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Information Transfer in Soviet Science and Engineering

A Study of Documentary Channels

Bruce Parrott

November 1981

Prepared for the
Defense Advanced Research Projects Agency



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PREFACE

This report, sponsored by the Defense Advanced Research Projects Agency, was prepared in the course of a study of Soviet science and technology under the Rand project entitled "Analysis of U.S./USSR Technology Issues."

The report examines the formal channels for communicating scientific and technical information in the USSR and evaluates the effectiveness of the system in transferring information within the USSR and in absorbing information from other technologically developed countries. A companion study will examine informal channels: communications among specialists, career mobility among R&D institutions, and higher education.

The report should be of interest to specialists engaged in the assessment of Soviet scientific and technological policies and achievements.

The author is a consultant to The Rand Corporation.

SUMMARY

Although Western scholars have examined Soviet research and development from many angles, they have generally neglected to study it as a process of information exchange. Consequently, little is known about how well Soviet scientists and engineers communicate with each other and with their foreign counterparts, or about how the supply of technical information affects the pace of Soviet scientific advance and technological innovation. This report seeks to enhance Western scholars' understanding of information exchange in Soviet science and engineering and thereby improve their assessment of Soviet R&D as a whole.

Information transfers may be classified according to whether they occur within a single R&D specialty or between specialties, whether they involve specialists working in only one or more than one phase of the R&D cycle, and whether they occur within a single geographic area or between areas. Information may be transmitted through various primary documentary channels, including specialized serials and books, unpublished technical and research reports, patent literature, industrial catalogs, and other engineering documents, and through secondary guides to primary documents. Major nondocumentary channels of information include professional contacts (sometimes called "invisible colleges"), career mobility, and higher education. The salient features of the Soviet approach to scientific and technical information include heavy emphasis on the central management of information, concentration on formal mechanisms of information transfer, and a tendency to underestimate the importance of disseminating information.

The Soviet network of information agencies and secondary information services publishes comprehensive, high-quality secondary information sources. Despite this major achievement, the Soviets have made little progress in providing computerized information services. Off-line selective dissemination of information (SDI) is available only to a small number of researchers in a limited number of fields; interactive, on-line searching of computerized data bases has not yet been introduced. The assistance that the information organizations give researchers in the physical acquisition of documents is hindered by the shortage of skilled personnel and copying equipment, particularly at the lower levels of the system.

Although the quantity of Soviet books and serials has increased in recent years, it appears that long delays in publishing completed Soviet research still substantially reduce the efficiency of the Soviet R&D effort. The delays stem mainly from the inadequate capacity of the Soviet publishing network (and perhaps also from editorial practices and censorship). Furthermore, the limited press-runs of Soviet specialized publications slow the diffusion of information to R&D institutions outside the main metropolitan centers.

Because of Soviet acquisition policies, several, but not all, fields of Soviet R&D show long delays in assimilating the contents of foreign scientific and technical publications. To save hard currency, the USSR does not acquire all foreign publications in science and technology, and, to the detriment of timely dissemination, it buys only limited quantities of important foreign publications. Here again, the nonmetropolitan R&D organizations are at a greater disadvantage. The information problem was exacerbated in the late 1970s by the rising costs of foreign journals, Soviet reluctance to spend hard currency, and Soviet adherence to the International Copyright Convention, which prohibits cover-to-cover copying.

Since the mid-1960s, the USSR has gradually improved bibliographic control over unpublished reports and dissertations and has made them more accessible. Three organizations have been involved in this effort. One catalogs all unclassified R&D projects in the USSR—from the time the project is first included in a research plan until it is completed or abandoned—and maintains microfilm copies of the reports on finished projects. Although circum-

stantial evidence indicates that many reports escape this collection effort, it is nevertheless impressively large. A second organization handles classified R&D information and appears to be responsible for channeling it to nonmilitary uses. A third organization handles the deposition of shorter scientific writings, primarily unpublished articles; this program is comparatively small, partly because scientists and journal editors have resisted government efforts to divert articles from journals to repositories.

Patents, equipment catalogs, and other engineering documents are not readily available. Despite major improvements in the patent system during the past fifteen years, the system still carries only a small proportion of Soviet scientific and technical information. The circulation of industrial catalogs—probably a more important channel of information for innovation, especially in capital construction—remains chaotic. It is difficult for Soviet designers to obtain foreign equipment catalogs. Domestic catalogs, with their highly unreliable information, cover only a limited fraction of the output of the Soviet machine-building branches. The unavailability of reliable catalogs reduces efficiency in designing capital projects, leads to the exclusion of some advanced equipment from new plants, and occasionally forces costly construction changes to compensate for a catalog's inaccuracy. The circulation of other engineering documents, such as standard construction designs and governmental directives on design procedures, is little better.

Since Stalin's death, the Soviet government has paid increasing attention to the management of scientific and technical information and has made major strides toward improving the flow of documents, but serious difficulties remain. A large amount of useful information, both domestic and foreign, is either lost entirely or underutilized. The scope of these difficulties helps to explain why, despite a large R&D effort, the USSR still lags behind the West in several scientific and technical fields. The weaknesses of the information transfer apparatus are rooted in several fundamental features of the Soviet system: a tendency toward bureaucratic autarky, a tendency not to coordinate the development of integrally related activities, and a deep suspicion of the outside world.

Of course, Soviet accomplishments in information handling derive from that same system's ability to mobilize resources and achieve economies of scale. Given the relationship of the shortcomings of information transfer to the larger political and economic structure of the country, however, the Soviet management of scientific and technical information, while it may improve, is likely to improve slowly.

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I would like to thank Simon Kassel for alerting me to the importance of this subject and for helping draw out the general implications of my empirical findings. I am also grateful to Loren R. Graham for his thoughtful suggestions on improving the report, and to Nancy Nimitz for her valuable comments on several specific points. J. E. Murray raised useful queries about the analysis. George Vladutz generously shared with me his first-hand knowledge of the Soviet information system. Christopher Naylor and Robert Paris were helpful in locating sources, and Maureen Cote's editing improved the style.

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AGENCY ACRONYMS

MTsNTI	International Center of Scientific and Technical Information (Mezhdunarodnyi tsentr nauchnoy i tekhnicheskoy informatsiy)
TsNIPI	Central Scientific Research Institute of Patent Information and Technical-Economic Studies (Tsentral'niy nauchno-issledovatel'skiy institut patentnoy informatsiy i tekhniko-ekonomicheskikh issledovaniy)
VIMI	All-Union Scientific Research Institute of Interbranch Information (Vsesoyuzniy nauchno-issledovatel'skiy institut mezhotraslevoy informatsiy)
VINITI	All-Union Institute of Scientific and Technical Information (Vsesoyuzniy nauchno-issledovatel'skiy institut nauchnoy i tekhnicheskoy informatsiy)
VINTI	All-Union Institute of Scientific Research Information for Agriculture (Vsesoyuzniy institut nauchno-issledovatel'skiy informatsiy po sel'skomu khozyaystvu)
VNIKI	All-Union Scientific Research Institute of Technical Information, Classification and Coding (Vsesoyuzniy nauchno-issledovatel'skiy institut tekhnicheskoy informatsiy, klassifikatsiy i kodirovaniya)
VNIIMI	All-Union Scientific Research Institute of Medical and Medical-Technical Information (Vsesoyuzniy nauchno-issledovatel'skiy institut meditsinskooy mediko-tekhnicheskoy informatsiy)
VNTITs	All-Union Center of Scientific and Technical Information (Vsesoyuzniy nauchno-tekhnicheskoy informatsionniy tsentr)

I. INTRODUCTION

In recent years Western scholars have examined Soviet science and engineering from many angles, ranging from budgetary allocations for R&D to the organization of industrial enterprises and the social status of researchers.¹ All these approaches are legitimate, and the studies based on them have produced valuable findings. But Western specialists on Soviet science and technology have generally neglected to study Soviet R&D as a process of information transfer, even though the approach has been widely used to analyze Western R&D and even though Soviet scholars have often adopted the approach in their own numerous studies of science and technology.²

As a result, the Western understanding of Soviet R&D is seriously deficient. The expeditious creation and exchange of information is the principal goal of basic researchers, and it is essential for the effective functioning of applied researchers and designers; yet we know very little about this process in the Soviet Union. Questions abound: How well do Soviet scientists communicate with each other and with their foreign counterparts? What channels of communication do they use? How much do engineers know of what the scientists are doing, and how do they find out? More broadly, how does the supply of information affect the pace of scientific advance and technological innovation? Questions of this kind are obviously of fundamental importance, but Western scholarship thus far has provided only impressionistic answers to them. As a result, U.S. policymakers who deal with technological trends and their international implications are forced to make intuitive assumptions about these matters; they frequently assume, for example, that technical information published in the U.S. is immediately absorbed by the Soviet Union.³ By addressing such questions systematically, a careful study of information flows can clarify the strengths and weaknesses of the Soviet R&D system. Empirical analysis can contribute to a more accurate assessment of the return that the USSR receives from its very large R&D expenditures, and to a surer appraisal of the benefits that it obtains from access to the findings of Western R&D.

Given the occasional proclivity of both Soviet and Western specialists on scientific information to treat the problem as an abstract matter of systems design, it should be stressed that the study of information transfer is no substitute for a knowledge of Soviet R&D budgets, research institutions, manpower levels, and so forth. Rather, it is a valuable complement to such knowledge. It is an especially fruitful way of analyzing how the Soviet political, social, and economic environment affects the professional transactions of Soviet scientists and engineers. By breaking down the process of information exchange into its many components, and by correlating this pattern with our broader knowledge of Soviet science and technology, we can learn a great deal about how societal conditions affect Soviet R&D.

The remainder of this report is divided into six sections. Section II provides an overview of the subject. It suggests some distinctions among various kinds of information transfer, and discusses the significance of the different channels, such as books, professional meetings,

¹For a useful survey of the literature on science, see Susan Gross Solomon, "Reflections on Western Studies of Soviet Science," in Linda L. Lubrano and Susan Gross Solomon (eds.), *The Social Context of Soviet Science*, Westview Press, Boulder, Colo., 1979, pp. 1-29.

²For an introduction to some of the Soviet work in this realm, see Linda L. Lubrano, *Soviet Sociology of Science*, American Association for the Advancement of Slavic Studies, Columbus, Ohio, 1976, and Yakov M. Rabkin, "Naukovedeniye: The Study of Scientific Research in the Soviet Union," *Minerva*, Vol. 14, 1976-1977, pp. 61-78.

³See, e.g., U.S. Congress, House of Representatives, Appropriations Committee, Subcommittee on the Department of Defense, *Department of Defense Appropriations for 1976, Part 4: Research, Development, Test, and Evaluation*, Government Printing Office, Washington, D.C., 1975, pp. 547-548. Nancy Nimitz kindly brought this item to my attention.

patent literature, and the like, through which information may be transmitted. The general Soviet approach to handling scientific and technical information is also described. Each of the remaining sections treats one or more specific channels of information transfer. Section III examines secondary sources of information, such as abstract journals and computerized information services, which can guide specialists to relevant primary sources. Section IV treats specialized serials and books. Section V deals with unpublished written sources, such as research reports and dissertations. Section VI considers published technical documentation, such as patent literature and industrial catalogs. Several other important modes of information transfer, although they are discussed generally in Section II for the sake of completeness, are not treated in detail in the body of this report. They include "invisible colleges" (a term describing various kinds of informal communication among specialists), career mobility among R&D institutions, and higher education. These avenues of information transfer will be examined in a separate report.

II. TYPES AND CHANNELS OF INFORMATION TRANSFER

A useful starting point for our investigation is to delineate some types of information transfer and the channels through which they may occur. By establishing this analytical framework at the outset, we will be better prepared both to organize and to interpret the large amount of source material on Soviet information exchange, and also to recognize the occasional points at which this body of material is insufficient to provide clear answers to our questions.

TYPES OF INFORMATION TRANSFER

At least three types of information transfer may be differentiated: by discipline, by R&D phase, and by geography. Categorization of information flows by discipline establishes how information moves within an individual specialty—say, solid state physics—or between two or more specialties—for example, between solid state physics and electrical engineering. Although only a small portion of the Soviet evidence lends itself to analysis in these terms, the distinction between intradisciplinary and interdisciplinary transfers is nevertheless useful. Many observers have suggested that the most creative R&D work results from interaction across disciplinary lines,¹ and the problem of effective interdisciplinary flows of information is therefore a matter worth bearing in mind as we proceed. How can the various channels of communication facilitate interdisciplinary transfer of information, and how well do they do so in the USSR?

Categorization of information flows by R&D phase is a second useful means of considering the ways that scientists and engineers interact. Viewed from this angle, information may be exchanged either among researchers working in the same phase of R&D—e.g., in fundamental research—or among researchers working in different phases of the R&D cycle—say, between specialists doing applied research in materials science and engineers designing a new metallurgical plant. The distinctions between basic research, applied research, development and production are not always clear-cut in practice, but they are important nonetheless. The effectiveness of a national R&D effort depends on the ready transfer of information between R&D phases, such as basic and applied, and on regular feedback from users to designers. It also requires the smooth communication of ideas and data within the same phase of the R&D process. The designers of a new metallurgical plant, for example, should know what kind of technology other designers have already incorporated into other plants. In the analysis that follows, we will want to inquire how well the Soviet information system promotes intraphase and interphase transfers of scientific and technical information.

A third criterion for classifying information transfers is spatial and political geography. The producer and the consumer of information may be located close or far apart, in the same country or in different countries. These factors often have a major impact on information flows. The farther apart two specialists are, the more difficult it will be for them to communicate personally, and the more they will tend to rely on formal channels of communication. Living in different countries may also affect the channels by which they communicate, especially if their countries are at odds politically or distrust foreign cultural influences. In the

¹See, for example, Don Price, *The Scientific Estate*, Galaxy Books, New York, 1965, p. 26; Gennadiy M. Dobrov, *Nauka o nauke* (The Science of Science), 2d ed., Naukova Dumka Publishing House, Kiev, 1970, pp. 198-199; D. Pelz and F. Andrews, *Scientists in Organizations*, John Wiley & Sons, Inc., New York, 1966, pp. 60-63.

following sections we will examine how well the Soviet system promotes the transfer of information among regions in the USSR, and, more important, since foreign science and technology constitute a vast information pool offering great potential benefits, how well the system promotes the acquisition and diffusion of information from abroad.

SECONDARY INFORMATION SERVICES

To find relevant information in the mass of primary documents that appear each year, R&D specialists everywhere must rely heavily on secondary sources such as *Physics Abstracts*, *Science Citation Index*, and so forth. These publications either classify primary printed sources according to subject or enable the specialist to discover relevant work by following chains of citations from one primary source to another. Many secondary sources also furnish short abstracts of the primary documents indexed. The effectiveness of such sources depends on the speed with which they report new publications, the accuracy with which they match their subject classifications to the shifting classifications employed by scientists themselves, and the quality of the abstracts provided.² (A subsequent section briefly considers the adequacy of Soviet secondary sources of this kind.)

In recent years many countries have created secondary sources covering unpublished documents as well; we will also examine Soviet innovations in this realm. Furthermore, many countries have begun to computerize their secondary information services. Computerization permits the selective dissemination of information (SDI) on a large scale. One form of SDI allows researchers to receive regular bibliographic updates according to a customized standing order, or profile, that describes their research interests. The spread of more sophisticated computer systems also allows researchers to query automated bibliographic data bases through on-line computer arrangements that provide more flexibility and precision in bibliographic searches and much more rapid responses than does off-line SDI based on a standing profile.³ Our empirical analysis will consider how far such methods of handling secondary information have developed in the Soviet Union and what their prospects are.

PRIMARY DOCUMENTS

Serials

In addition to a well-developed network of secondary information sources, the process of information transfer of course depends on the number and quality of the primary documents themselves. One of the most important vehicles for disseminating primary documents is the specialized serial—a term that covers periodicals appearing at regular intervals, and ongoing series appearing at irregular intervals, such as the “proceedings” of a research institute.

In basic research, serials, and more particularly journals, have become the principal printed medium for the communication of findings among scientists. Most of these publications concentrate on a narrowly defined field, which helps to guide scientists to writings relevant to their own research. Moreover, the contents of these publications are subject to some quality control by journal editors and specially appointed referees, who evaluate proposed articles for

²For a brief discussion of the problems raised by the imperfect fit between the categories used by researchers, indexers, and readers, see Diana Crane, *Invisible Colleges*, paperback ed., University of Chicago Press, 1972, pp. 118-120.

³For a review of recent Western developments in off- and on-line SDI, see J. E. Rowley and C.M.D. Turner, *The Dissemination of Information*, Westview Press, Boulder, Colo., 1978, Chap. 6.

competence and novelty.⁴ Another advantage is that serials, being produced fairly quickly, offer the most timely formal information on particular fields of research—although virtually all formal documents lag considerably behind the latest research developments. The chief disadvantage of serials is that they often presuppose a sophisticated knowledge of the subject and are therefore inaccessible to specialists who are on the margin of the specialty or whose scientific training is dated. Consequently, serials concentrating on the latest R&D findings are likely to be relatively ineffectual vehicles for the wide dissemination of those findings to the many practicing engineers who must ultimately apply technological ideas, although intermediary serials may help to bridge this gap.⁵ As we examine the Soviet network of scientific and technical serials, we will pay particular attention to how rapidly they process and publish proposed articles. Do they ensure that recent findings will be quickly incorporated into the formal domain of science, or are long lags common? Also, how well do Soviet serials bridge the gap between the scientist working at the research front and the many specialists who must develop and apply his ideas to routine production?

Books

While they are less timely than serials, books usually offer a more synthetic view of a given technical problem or field of specialization. Consequently, they are an important medium for diffusing knowledge to researchers in related fields and to practicing engineers who lack the time or expertise to follow the latest developments through serial publications. Like serials, books are generally subject to some quality control. They also provide essential reference information in the form of handbooks, compilations of tables, and so on, for both researchers and practicing engineers. They are also, of course, the primary medium by which students—the R&D specialists of the future—learn the fundamentals of their specialties. The quality of textbook publication in science and technology therefore exerts a delayed but strong influence on the research frontier.

Unpublished Technical and Research Reports

Unpublished technical and research reports are also important primary documents. Judging by Western experience, such reports are particularly significant in communication among certain kinds of specialists. American and British technologists working in the development and production phases of the R&D cycle rely more on such documents than on published journals.⁶ Although there are no reliable statistics on the number of unpublished reports, they appear to be growing in prominence as a source of information. One possible explanation of that growth is that today's scientists and engineers, because they work in larger teams and organizations than in the past, may communicate within these settings by means of

⁴For an analysis of the referee process in American scientific journals, see Harriet Zuckerman and Robert K. Merton, "Patterns of Evaluation in Science: Institutionalisation, Structure and Functions of the Referee System," *Minerva*, Vol. 9, 1971, pp. 66-100. Such evaluation also serves to concentrate research of higher quality in certain prestigious journals; but it does not seem to keep a great deal of the lower-quality research from being published in less prestigious journals, at least in the U.S. A large study of American scientific communication found that of the articles refused for publication by the first journal to which they were submitted (12.5 percent of the total submitted), roughly half were resubmitted to another journal without revisions and were accepted. William D. Garvey, Nan Lin, and Kazuo Tomita, "Research Studies in Patterns of Scientific Communication: III. Information-Exchange Processes Associated with the Production of Journal Articles," *Information Storage and Retrieval*, Vol. 8, 1972, pp. 213-214.

⁵Donald G. Marquis and Thomas J. Allen, "Communication Patterns in Applied Technology," *American Psychologist*, Vol. 21, 1966, pp. 1056-1057. The authors conclude that in the U.S. a network of trade journals—journals lacking scholarly apparatus and published by commercial publishers instead of by scientific and engineering societies—has evolved to narrow the gap.

⁶*Ibid.*, p. 1056.

unpublished rather than published writings. A second explanation is that military R&D programs are increasing in research intensity and scope. Governments sponsor more defense research and engineering today than in the past, and for security reasons much of this work is not published, at least at the time it is performed. Many of the resulting reports contain data of value to nonmilitary R&D projects, and if they can be safely declassified, they increase the effectiveness of a country's overall R&D effort. Therefore, our analysis needs to consider how the Soviet system affects the circulation of unpublished reports. In addition, we need to locate evidence concerning whether the regime has provided for transferring military-related information to nonmilitary users.

Patents, Catalogs, and Other Documents

Patent literature, industrial catalogs, and miscellaneous engineering documents constitute a major channel of information transfer. Patent literature informs applied researchers and engineers about the technological achievements of their predecessors and counterparts working in other organizations and other countries. In the West a preponderant share of the information in patent specifications is not published in other sources, either before or after the publication of the specifications themselves.⁷ Neglect of the patent literature, then, may entail a serious loss of valuable technical information. In nonsocialist countries, of course, the information in patent specifications is not a free good; readers may have to pay the patent holder for the right to use the information in a new product or process, or they may be denied the right to do so under any conditions. In the Soviet Union, by contrast, virtually all inventions that are legally registered receive an "author's certificate," which guarantees the inventor a monetary award for the use of his invention but reserves to the government all decisions about the invention's application. (For the sake of simplicity we shall refer to these certificates, together with the few full patents which the Soviet government grants—mostly to foreign applicants—as "patents," but the special meaning of the term should be kept in mind.) The lack of legal restrictions on the public use of inventions in the Soviet Union means that the literature describing inventions is, at least potentially, a very important avenue for the exchange of technical information among Soviet scientists and engineers. In our empirical analysis we will consider how well it performs this function.

Industrial catalogs are also a vehicle for exchanging information. Although Western academic authorities on information systems sometimes neglect catalogs, possibly because they regard them as bearers of commercial rather than strictly technical data, catalogs perform a central function in the R&D process. Their creation and wide dissemination enables applied researchers and, especially, industrial designers to learn about the latest physical technology available for incorporation into their own work. Lacking such information, designers may plan huge expenditures on investments that are not up to date technologically, thereby short-circuiting an R&D system that is well supplied with other kinds of information. In a subsequent section we will look into the Soviet system's handling of industrial catalogs and related engineering documents.

⁷A study of a large sample of British patents issued in the 1960s found that only 3.3 percent of the mechanical, 7.5 percent of the electrical, and 8.6 percent of the chemical inventions were discussed in other published sources covered by the major relevant abstracting services. F. Liebesny et al., "The Scientific and Technical Information Contained in Patent Specifications—The Extent and Time Factors of Its Publication in Other Forms of Literature," *The Information Scientist*, Vol. 8, No. 4, 1974, pp. 165-177. Because a large number of non-British sources are covered by these services and because roughly two-thirds of the patents in question belonged to foreigners, it appears that there may be very little redundancy between patent documents and technical publications in other Western countries as well. See also K. M. Saunderson, "Patents as a Source of Technical Information," *Aslib Proceedings*, Vol. 24, No. 4, 1972, pp. 244-254.

Nondocumentary Communication Networks

Professional Contacts. Intertwined with the documentary channels of information transfer enumerated above are less formal networks of communication, sometimes known as "invisible colleges." These networks join specialists who have closely related research interests, and they frequently extend across national boundaries.⁸ Invisible colleges are sustained by many kinds of personal contact among specialists, such as conversations in the work place, meetings at scientific conferences, correspondence, telephone conversations, and distribution of preprints of forthcoming articles. These relationships complement more formal mechanisms of information exchange. Invisible colleges are extremely efficient in keeping prominent specialists fully abreast of their colleagues' work. In the U.S., for example, a scientist attending a national professional meeting learns the contents of many future journal articles at least a year before they are published, and he may encounter a large amount of useful material, particularly in the presentations of engineering scientists, that will not be published at all.⁹ Informal ties among specialists provide "selective switching" in R&D by channeling relevant information to those who want it. They also give immediate feedback to scientists and engineers on the plausibility of their new ideas; and they convey background knowledge about the craft of a particular R&D specialty, knowledge that published sources often do not provide.¹⁰ Recent observers of Western R&D have discovered that a large amount of useful information reaches researchers through these informal channels.¹¹ Nevertheless, it should be emphasized that invisible colleges are a complement to effective formal communication, not a substitute for it. The formal process of publication furnishes the documents to which the members of an invisible college often refer each other in their informal contacts, and it diffuses their research findings to the many R&D personnel who are not included in the network. Publication also provides a level of quality control that informal communication cannot assure.¹² Finally, publication performs the indispensable function of cumulating and preserving the discoveries of the scientific and engineering professions.

Personnel Mobility. The movement of R&D personnel from one job to another is closely related to invisible colleges. This kind of career mobility disseminates information among research and engineering establishments by transplanting the bearers of new knowledge from one institution to another. Western studies have concluded that the movement of specialists is the most effective way of assuring the assimilation of new technology by persons

⁸The term "invisible college" was coined by Derek de Solla Price; see his *Little Science, Big Science*, Columbia University Press, New York, 1963, Chap. 3. The most extended treatment of this idea is Crane, *Invisible Colleges*. For the international dimension, see Gerald Zaltman, "A Note on an International Invisible College for Information Exchange," *Journal of the American Society for Information Science*, Vol. 25, No. 2, 1974, pp. 115-117.

⁹K. Subramanyam, "Scientific Literature," in *Encyclopedia of Library and Information Science*, Vol. 26, Marcel Dekker, Inc., 1979, p. 432; William D. Garvey, Nan Lin, and Kazuo Tomita, "Research Studies in Patterns of Scientific Communication: II. The Role of the National Meeting in Scientific and Technical Communication," *Information Storage and Retrieval*, Vol. 8, 1972, p. 166.

¹⁰Herbert Menzel, "Informal Communication in Science: Its Advantages and Its Formal Analogues," in Edward B. Montgomery (ed.), *The Foundations of Access to Knowledge*, Syracuse University Press, Syracuse, New York, 1968, pp. 153-164.

¹¹According to a study of several groups of applied researchers and electrical engineers, personal contacts with other specialists provided from 25 to 48 percent of the total information obtained by members of the group; in one exceptional case the figure reached 64 percent. Calculated from Richard S. Rosenbloom and Francis W. Wolek, *Technology and Information Transfer: A Survey of Practice in Industrial Organizations*, Harvard Graduate School of Business Administration, Boston, Mass., 1970, pp. 69-71. See also William J. Price and Lawrence W. Bass, "Scientific Research and the Innovative Process," *Science*, Vol. 164, No. 3881, May 15, 1969, pp. 805-806, and Nathan Rosenberg, "Economic Development and the Transfer of Technology: Some Historical Perspectives," *Technology and Culture*, Vol. 11, 1970, pp. 552-555.

¹²The need to balance the separate goals of free communication and quality control has aroused considerable controversy among Western scientists; see, for example, Crane, pp. 121-122. Similar controversies have arisen in the USSR.

unfamiliar with it.¹³ This suggests that the organizational practices and social conditions affecting the career mobility of specialists among R&D institutions are likely to have a strong influence on the transfer of scientific and technical information.

Professional mobility may be influenced by organizational policies such as the availability of extended leaves, the degree of protection afforded by rules of tenure, the transferability of pension rights, and the importance of having one's career backed by a powerful scientific patron.¹⁴ Socially, the decision to move to a new job is likely to be influenced by the number of research jobs available and by personal traits of venturesomeness or caution. Also relevant are the salary differentials between institutions, the availability of housing and cultural amenities in new job locations, and any noneconomic factors (e.g., the Soviet system of residential permits) that may impede moving to still another new job. Although such matters ordinarily fall outside the purview of specialists on information systems, they materially affect the operation of information systems.

Higher Education. Education is important for obvious reasons; less obviously, it also appears to be vital in the transfer of information between phases of the R&D cycle. Some Western writers have suggested that education is the principal connection between basic research and technology. In this view, technologists rely primarily on the scientific knowledge that was "ambient" during their years as students; they do not and cannot stay abreast of the basic research findings that appear after they complete their formal education.¹⁵ The relationship between contemporaneous research and technological innovation is a controversial point that is difficult to resolve through empirical investigation. But at the very least, higher education is clearly a critical avenue for the diffusion of basic scientific knowledge to future scientists and engineers. If the textbooks they read are outdated, or if they are not exposed to pioneering scientific work while in the higher schools, it is improbable that they will regain this lost ground later in their careers. The functioning of the higher educational system is therefore significant for the operation of the information system as a whole.

The preceding pages furnish a basis for analyzing how particular channels of communication function in the USSR. Before beginning this task, however, it will be useful to review the salient features of the general Soviet approach to scientific and technical information.

First, the Soviet regime puts unusually heavy emphasis on the central management of information, in keeping with its central direction of the whole economy and society. During most of the Stalin period, the information system received little direct attention. The authorities tended to assume that efficient information exchange was an automatic by-product of state control and planning of research and production. Since the early 1950s, the regime has gradually recognized that this is not so, and has built up a comprehensive network of organizations to register and help disseminate scientific and technical documents. That does not imply a loss of faith in centralization, however. On the contrary, the Soviet network of information agencies is probably the most highly centralized in the world.

The emphasis on centralization is linked to a second feature of the information system: concentration on formal mechanisms of information transfer. Because central management of communication works more effectively for documentary than for personal channels of exchange, the regime has focused on disseminating information through documents rather than more spontaneous, informal channels. This emphasis applies especially to the international exchange of information; the political authorities remain wary of "subversive" cultural and

¹³J. Langrish et al., *Wealth from Knowledge: A Study of Innovation in Industry*, Macmillan, London, 1972, p. 43.

¹⁴For the effects of these factors in France, see Ronald Brickman, "The Promotion of Mobility of Scientists: A Problem of French Science Policy," *Minerva*, Vol. 15, 1977, pp. 62-82.

¹⁵Derek de Solla Price, "Is Technology Historically Independent of Science? A Study in Statistical Historiography," *Technology and Culture*, Vol. 6, 1965, pp. 553-565, and "The Structure of Publication in Science and Technology," in William H. Gruber and Donald G. Marquis (eds.), *Factors in the Transfer of Technology*, MIT Press, Cambridge, Mass., 1970, p. 98; Langrish et al., pp. 35-39.

political influences that may accompany personal contacts between Soviet and foreign specialists.

A third feature of the system is the tendency for many persons outside the information organs to underestimate the importance of disseminating scientific and technical information. However paradoxical it may seem in a society deeply committed to the promotion of science and technology, this attitude is real. In part it stems from the efforts of the Soviet leaders and censors to insulate the population from external sources of information about foreign cultures. In part it grows out of their attempts to keep foreigners from learning about Soviet scientific and technical achievements that have military applications. No less important than these motives, however, is the diffuse Soviet attitude that the exchange of ideas is something that must be carefully controlled lest it get out of hand, instead of something to be encouraged as a social good. Although Soviet theorists of economic planning and research management regularly argue that information exchange is highly desirable, the ingrained political and economic culture assigns a low value to the benefits of open and extensive communication. This attitude necessarily affects information transfer in science and engineering, as we shall see in subsequent sections.

III. INFORMATION AGENCIES AND SECONDARY INFORMATION SERVICES

The network of information organizations mentioned at the end of Section II is the institutional core of the Soviet information system. This section outlines the administrative structure of these information agencies, and then discusses the secondary information sources that they produce—the kinds of published and computerized guides to primary sources of scientific and technical information, and their quality. The discussion also touches on the direct assistance that the information organizations give researchers in the physical acquisition of primary scientific and technical documents, although several aspects of the acquisitions process will be deferred to subsequent sections. Besides explaining the particulars of the information network, this section will give us some insight into the ways in which the general structure and traditions of Soviet society have shaped the management of scientific and technical information.

THE AGENCIES AND THEIR SECONDARY PUBLICATIONS

At the apex of the information network are several all-union agencies whose responsibilities are divided by broad forms of information. The most important is the All-Union Institute of Scientific and Technical Information (VINITI), which indexes and abstracts books, articles, and patents, and serves as the principal center for the scholarly study of the Soviet information system as a whole. VINITI handles the bulk of the published literature in the natural sciences and technology, but publications in medicine and agriculture are the domain of two other agencies, the All-Union Scientific Research Institute of Medical and Medico-Technical Information (VNIIMI) and the All-Union Institute of Scientific Research Information for Agriculture (VINTI). Dissertations and unpublished scientific and technical reports, including those deemed confidential by the government but not classified as state secrets, are the province of the All-Union Center of Scientific and Technical Information (VNTITs). Classified reports, together with defense-related materials obtained abroad illegally, are managed by the All-Union Scientific Research Institute of Interbranch Information (VIMI).¹ Foreign and domestic patent literature is processed and indexed by the Central Research Institute for Patent Information (TsNIPI). The All-Union Research Institute of Technical Information, Classification and Coding (VNIKI) administers the indexing and dissemination of Soviet (and to some extent foreign) industrial standards and technical norms. These are the most important all-union agencies for this analysis.

The next tier of central information agencies consists of some 86 bodies built around functional branches of information—for example, the Central Information Institute of the Ministry of Instruments, Means of Automation, and Control Systems. These central branch organizations handle all forms of documents, concentrating on the materials of each type that fall within their field of specialization. Below the central level are 15 republican institutes of information (one for each republic), which handle all the forms and branches of information

¹From George Vladutz, "The All-Union Institute for Scientific and Technical Information (VINITI)," paper presented at the Harvard University Russian Research Center, April 10, 1980, p. 1, and from comments by Dr. Vladutz in the discussion which followed. Dr. Vladutz, employed at VINITI from 1956 to 1974, was the organizer and head of its department of chemical information systems, and later head of its department of semiotics. He is currently manager of basic research at the Institute for Scientific Information in Philadelphia. I am indebted to him for several lengthy and enlightening discussions of the Soviet information system.

relevant to their particular geographic area. At the next lower level of the hierarchy are some 97 territorial information centers, organized on the same interdisciplinary principle as the republican agencies. Finally, at the base of the hierarchy are more than 11,000 information departments in individual institutes, design offices, and enterprises. These local units frequently serve as intermediaries for scientists and engineers in search of useful information.²

The all-union agencies issue so wide a range of secondary publications that only a few can be cited here. The most important is the *Abstracts Journal* (*Referativnyi zhurnal*), which appears semimonthly and monthly in several dozen specialized series. Other major guides are *Signal Information* (*Signal'naya informatsiya*) and *Express Information* (*Ekspress informatsiya*), which also appear in numerous specialized series and are intended to provide more timely indexing and selective abstracting of recent publications than does the *Abstracts Journal*.³ As another secondary aid, VINITI and the major Soviet scientific and technical libraries began services in the 1970s that now reportedly list the contents of some 8000 foreign journals within 10 days of their receipt.⁴ For a more general perspective, Soviet specialists may turn to the publications in the series *Summaries of Science and Technology* (*Itogi nauki i tekhniki*), which provide integrated reviews of the recent publications in particular fields of R&D. To stay abreast of unpublished research reports, specialists may consult the various thematic series published under the general titles *Collection of Abstracts of Scientific Research Projects* and *Collection of Abstracts of Scientific and Experimental Design Projects* (*Sbornik referatov NIR* and *Sbornik referatov NIR i OKR*).⁵ To follow trends in research still in progress, they may refer to the various series of the *Registration Bulletin of Research and Design Projects* (*Byulleten' registratsii NIR i OKR*). In addition to compiling such secondary guides, some of the all-union organizations operate very large reproduction facilities that supply, on request, copies of the primary documents that they index.

The quality of these secondary information sources is very high on the whole. The *Abstracts Journal*, in particular, contains an enormous quantity of bibliographic information about recent publications and patents. The range of primary literature that it covers compares very favorably with the coverage of major Western secondary information services such as *Chemical Abstracts*, and the quality of the abstracts is generally regarded as excellent. The *Abstracts Journal* also ranks high in the short time it takes to abstract and index a published article. Between 1960 and 1975 this time was cut from between 8 and 9 months to 3.8 months, which is roughly on a par with the best non-Soviet abstract services.⁶ It is true that the all-union information organizations have not always quickly adopted new forms of publication to speed the transmission of secondary information. The Soviet "current contents" service, for example, first appeared some fifteen years after the advent of such a service in the U.S., and Soviet information specialists are still debating the advisability of setting up a Soviet version of the *Science Citation Index*.⁷ But the all-union organizations have also

²All the figures from this paragraph are from N. B. Arutyunov, "The Development of the State System of Scientific-Technical Information," *Nauchno-tekhnicheskaya informatsiya* (hereinafter called *NTI*), Series 1, No. 11-12, 1977, p. 3. The local units are known both as *informatsionnye otdely* and as *informatsionnye byuro*.

³In the early 1970s the *Abstracts Journal* appeared in 63 separate periodic volumes, some of which covered more than one field of science or technology. *Ekspress informatsiya* appeared in 78 separate series (*Bol'shaya sovetskaya entsiklopediya*, 3d ed., Vol. 10, Moscow, 1972, p. 350).

⁴"The Status and Prospective Development of the Scientific Information System," *Vestnik Akademii nauk SSSR* (Herald of the Academy of Sciences, USSR; hereinafter called *VAN SSSR*), No. 3, 1973, p. 4; A. V. Blek, *Informatsionnoye obespecheniye nauchnykh issledovaniy* (The Informational Support of Scientific Research), Nauka Publishing House, Leningrad, 1974, p. 91; M. P. Knyazeva, "Scientific-Technical and Specialized Libraries in the State System of Scientific-Technical Information," *NTI*, Series 1, No. 11-12, 1977, p. 65. According to Knyazeva, these services are now used by 20,000 organizations and enterprises.

⁵Ye. A. Novikov and V. S. Yegorov, *Informatsiya i issledovatel'* (Information and the Researcher), Nauka Publishing House, Moscow, 1974, pp. 164-165.

⁶A. I. Mikhaylov, Ye. V. Tarasov, and A. S. Kulagin, "The Effectiveness of Scientific-Technical Information," in *Nauka, informatsiya, proizvodstvo* (Science, Information, Production), VINITI, Moscow, 1977, p. 18.

⁷V. V. Nalimov and Z. M. Mul'chenko, *Naukometriya* (Scientometrics), Nauka Publishing House, Moscow, 1969, p. 95; Blek, p. 91. It should be noted that a good case can be made against a Soviet *SCI*. Because Soviet researchers

introduced some valuable new publications. Judging by Soviet descriptions, the *Registration Bulletin of Research and Design Projects* probably has no Western equal as a comprehensive guide to the topics of domestic R&D in progress.⁸ On balance, then, the information organizations seem to have diligently maintained and improved the complement of secondary information publications. According to a recent survey of Moscow scientists and engineers, only 2 to 8 percent of the respondents expressed dissatisfaction with Soviet secondary publications.⁹ The principal problems facing the information agencies have to do not with the quality of these publications, but with other factors. These problems are discussed below.

INADEQUATE COMPUTERIZATION

One major difficulty is the computerization of the information network. Successful computerization allows secondary information to be disseminated in an unpublished format that is tailored to the needs of individual researchers and gives users more flexibility in pursuing bibliographic leads. Soviet arrangements for computer-based selective dissemination of information (SDI) are extremely underdeveloped by Western standards. VINITI runs a service, primarily for members of the Academy, that conducts batch searches of recent bibliographic data in a limited number of fields according to profiles of interest filed by the subscribers.¹⁰ The ministries of control systems and precision instruments, electrical engineering, and electronics have similar automated branch SDI systems that serve several hundred R&D organizations connected with each ministry. Additional branch systems are reportedly being developed.¹¹ The coverage of such services is still restricted to a narrow range of specialties, however, and the number of scientists and engineers entitled to use them is comparatively small. Of necessity, the directors of research institutes and design bureaus must ration access to these services, and the competition for the director's backing pits one researcher against another.¹² In consequence, this kind of SDI is available only to a thin stratum of researchers and engineers working at the forefront of some scientific and technical fields.

Many Soviet information specialists wish to increase the scale of computerized SDI, but some thorny problems stand in the way. In 1978 a national conference on the automated processing of scientific and technical information offered a sombre picture of the difficulties.¹³ Although the various all-union information agencies have set up automated systems for internal processing of their own bibliographic data, administrative coordination in designing these systems has been lacking.¹⁴ Differences in the software used by various organizations

can already use the American *SCI*, Soviet resources that would go into a Soviet version might conceivably be better spent elsewhere.

⁸As far as I know, this publication is not available outside the USSR.

⁹Mikhaylov, Tarasov, and Kulagin, pp. 17-18.

¹⁰"Status and Prospective Development," p. 4; telephone interview with Dr. George Vladutz, July 17, 1980. Dr. Vladutz estimates that 200 to 300 academicians presently use this service. See also L. M. Shulov et al., "Informational Needs of Chemists Subscribing to the 'Flor' Automated Factographic SDI," *NTI*, Series 1, No. 1, 1976, p. 12.

¹¹V. A. Rukhadze et al., "An Experiment in the Exploitation of the 'Referat' Branch Automated System for Scientific-Technical Information," in *Nauka, informatsiya, proizvodstvo*, VINITI, Moscow, 1977, pp. 38-45; telephone interview with Dr. Vladutz, July 17, 1980; A. I. Mikhaylov et al., "The Basic Principles for Building a Network of Automated Centers for NTI," *NTI*, Series 1, No. 11-12, 1977, p. 11.

¹²Telephone interview with Dr. Vladutz, July 17, 1980.

¹³"Problems of Automated Processing of Scientific-Technical Information (Materials from the Second All-Union Scientific-Technical Conference)," *NTI*, Series 1, No. 11, 1979, pp. 29-30. Perhaps the gravity of the problems explains why it required a year for a short summary of the conference's conclusions to be published.

¹⁴*Ibid.*; Mikhaylov et al., "Basic Principles," pp. 5, 11.

¹⁵"Problems"; Arutyunov, p. 3; A. K. Ailamazyan, "A System for Disseminating Information Concerning Unpublished Documents on Magnetic Tape," *NTI*, Series 1, No. 8, 1979, p. 4.

make many of the systems incompatible. Sometimes even organizations using compatible software and hardware cannot exchange data because of "custom" changes that they have made to their computers such as the installation of nonstandard tape-drivers.¹⁵ In these respects the automation of scientific and technical information reflects the same problems of software deficiencies and unreliable vendor services that afflict other aspects of the Soviet computerization effort.¹⁶ There is considerable evidence that these problems have been compounded by institutional rivalries and disagreements about the proper relation between the proposed computer network for scientific and technical information and the larger automated management systems that are supposed to improve the central administration of Soviet society as a whole.¹⁷ Furthermore, in order for the central information organizations to distribute copies of their data bases to lower-level information organizations and R&D institutions themselves, it is necessary to build up not only the copying facilities of the central organizations but also the computer capacities of the lower organizations, many of which are not presently equipped to process magnetic tapes.¹⁸ This is an expensive proposition, and it puts a heavy additional demand on the Soviet computer industry.

The effort to give scientists and engineers remote on-line access to the data bases of the central information agencies has been even less successful. On-line access is a superior source of secondary information because it takes less time and offers more search flexibility than do preformulated requests, which cannot be modified while the computer search is going on. Soviet progress on this front is exceedingly slow. The resolutions of a conference in late 1978 complained that too little was being done to allow users direct access to bibliographic data bases. Toward the end of 1979, the head of VINITI acknowledged that it was still impossible to set up a terminal giving direct access to the data bases of VINITI.¹⁹ The effort to provide such access for a large number of scientists and engineers runs up against more serious impediments than does the attempt to promote batch-processing of SDI requests. On-line access requires more of the printers, teletypes, visual displays, remote terminals, and other peripheral equipment which, Soviet specialists complain, is in very short supply.²⁰ In addition, it requires that the whole communications network be upgraded to handle such traffic quickly and reliably. According to one report, the government intends to make a short-run effort to enlarge the capacity for exchanging bibliographic information (as well as other kinds of data) through a set of dedicated communications channels, such as direct cables. In the long run, data transmission will be shifted to regular multiple-use communications channels, such as telephone and teletype.²¹ To make the shift, however, authorities must modernize the Soviet telephone system—notoriously inefficient and short of switching capacity—at the cost of extremely large capital investments. Until this transition can be made, the number of terminals offering on-line access to bibliographic data bases will be restricted by the lack of a comprehensive network of dedicated channels. Hence the scope of on-line access to secondary scientific and technical information is likely to remain small for the foreseeable future.

¹⁶S. E. Goodman, "Computing and the Development of the Soviet Economy," in *Soviet Economy in a Time of Change*, Vol. 1, Government Printing Office, Washington, D.C., 1979, esp. pp. 524-531.

¹⁷"Problems"; A. Z. Kulebyakin and E. V. Kiulo, "Building a Scientific-Technical Data Transmission Network," *NTI*, Series 1, No. 3, 1979, pp. 1-3. At a large conference on scientific and technical information, one specialist suggested heatedly that specialists on automated management systems had "no correct idea at all" about technical information and that this was "one of the very sharpest problems" facing information specialists. "Current Problems of Establishing a State Automated System of Scientific and Technical Information," *NTI*, Series 2, No. 10, 1977, p. 28.

¹⁸"The Management of Informational Means as a Condition for Scientific Activity," *VAN SSSR*, No. 9, 1979, p. 42.

¹⁹"Problems"; "Management," p. 43.

²⁰"Problems."

²¹"Current Problems."

INADEQUATE LOCAL INFORMATION SERVICES

An equally serious difficulty is the inadequate quality of the services provided by the local information departments. Soviet observers have long complained that these departments are the weakest element in the pyramid of information organization. A survey of working scientists and engineers found that only 30 percent of the respondents were satisfied with the information services offered in their place of work.²² One of the main reasons for this weakness is a shortage of properly trained personnel. Soviet writers insist that this problem is real, even though the aggregate statistics on "specialists" at various levels of the information network show no relative shortage of persons with higher education in the local departments.²³ The explanation is that the local "specialists" are often trained in fields having nothing to do with the management of scientific and technical information—fields such as the humanities.²⁴ The government has set up a special program to train and retrain information specialists, but according to one observer it is still far from meeting the system's manpower requirements,²⁵ and there are good reasons for the graduates of the program to seek employment in the higher-level information agencies. Employment at the lower levels confers little social status or economic benefit, and information workers are not always appreciated by their immediate supervisors.²⁶ In 1974 the government took administrative steps to upgrade the status of information departments within institutes, design bureaus, and enterprises. But many directors of such establishments reportedly still regard their information departments as auxiliary rather than essential parts of the organization.²⁷ These officials, particularly those who head applied research and manufacturing units, are often under pressure to fulfill their organization's annual plan more in terms of project expenditures or gross output than in terms of technical quality,²⁸ and this "production ethic" doubtless encourages them to underestimate the value of good information specialists.

The weakness of local information departments in staffing is matched by their shortage of equipment, especially copying equipment.²⁹ A high government official responsible for the diffusion of scientific and technical information has stressed that there is a dearth of such equipment and that greater quantities must be provided to lower-level information units.³⁰ One reason for the shortage at lower levels is that the central information organizations exercise special claims to obtain the lion's share of the limited amount of available equipment. But part of the explanation is political. The Soviet regime is politically secretive, and it is sharply aware that equipment used to copy scientific articles can also be used to copy uncensored political and social writings. A large increase in institutions with copying facilities would greatly heighten the difficulty of controlling such *samizdat* ("self-published") writings, which the regime regards as subversive. Although the political authorities rarely refer to this problem in public, their concern is clear. Purchase orders for copying equipment

²²O. V. Kedrovskiy, "Improving the System of Scientific-Technical Information and the Goals of Informational Activities," *NTI*, Series 1, No. 1, 1977, pp. 3-4; Mikhaylov, Tarasov, and Kulagin, p. 20.

²³V. I. Gor'kova, "Training and Improving Personnel Qualifications," *NTI*, Series 1, No. 3, 1977, p. 26. There is a relative shortage in the intermediate, "territorial" agencies.

²⁴Blek, pp. 126-127. A Leningrad survey of 36 engineering and chemical engineering institutes between 1968 and 1971 found that only 14 had specialists formally designated to handle information work; some of these were philologists. S. A. Kugel' et al. (eds.), *Nauchniye kadry Leningrada* (The Scientific Manpower of Leningrad), Nauka Publishing House, Leningrad, 1973, p. 73.

²⁵Yu. Yu. Ukhin, "Training Personnel and Improving the Qualifications of Information Workers," *NTI*, Series 1, No. 11-12, 1977, p. 59.

²⁶Blek, p. 92; Kedrovskiy, pp. 3-4.

²⁷V. M. Batrakov, "Information Activity in Machinebuilding Design Bureaus," *NTI*, Series 1, No. 5, 1978, p. 2.

²⁸Bruce Parrott, "The Organizational Environment of Soviet Applied Research," in Linda L. Lubrano and Susan Gross Solomon (eds.), *The Social Context of Soviet Science*, Westview Press, Boulder, Colo., 1979, pp. 68-100; Joseph Berliner, *The Innovation Decision in Soviet Industry*, MIT Press, Cambridge, Mass., 1976.

²⁹Kedrovskiy, pp. 3-4; Arutyunov, p. 4.

³⁰Arutyunov, p. 4. Arutyunov heads the department of the State Committee for Science and Technology that oversees the dissemination of scientific and technical information.

must be accompanied by an authorization from the Ministry of Internal Affairs,³¹ and reports from many emigre scientists indicate that the secret police keep tight control over the operation of copying facilities in higher educational institutions and research establishments. Occasionally a small public sign of official concern surfaces. In 1978, for example, the party issued an order authorizing officials of borough and city soviets to levy fines on persons who violate the rules governing the acquisition and use of printing and copying equipment. These fines may be levied administratively, i.e., without formal legal proceedings, on the basis of protocols furnished by representatives of the Ministry of Internal Affairs.³²

The shortage of copying equipment impedes the movement of unpublished scientific and technical information from research and engineering organizations to the central information agencies and to other scientific users. Soviet observers have repeatedly pointed out that the sluggish upward flow of information is one of the most serious weaknesses of the information system;³³ we shall return to this theme below. In addition, the shortage of copying technology contributes to delays in obtaining copies of primary scientific and technical publications. Although VINITI and VNTITs strive to respond quickly to requests for copies of the documents that they index, filling all such orders for the entire country is a mammoth undertaking. The wider availability of copying equipment at lower administrative levels would relieve some of the current congestion. It is clear that the information system as a whole is not yet meeting the demand for quick access to primary documents, at least if we accept the judgment of Soviet researchers themselves. In the sample of scientists and engineers that expressed general satisfaction with Soviet secondary publications, 70 percent expressed dissatisfaction with the performance of the information system in supplying originals or copies of primary documents in response to researchers' requests.³⁴ Thus, it appears that the system's cumbersome handling of primary documents is an even worse bottleneck than the provision of computerized secondary information. An examination of the Soviet management of books and serials will illuminate the extent of this problem.

³¹See the advertisement on the last page of *Ekonomika sel'skogo khozyaystva* (The Economics of Agriculture), No. 11, 1976. I am grateful to Nancy Nimitz for bringing this item to my attention.

³²*Spravochnik partiynogo rabotnika* (Handbook for the Party Worker), Politizdat, Moscow, 1979, pp. 270-271. To the best of my knowledge, the rules themselves have not been published.

³³See, e.g., Arutyunov, p. 4.

³⁴Mikhaylov, Tarasov, and Kulagin, p. 18.

IV. SERIALS AND BOOKS

According to the available field surveys, Soviet basic researchers regard serials and books as by far the most valuable documentary sources of primary information. Scientists and engineers working in development value them almost as highly.¹ Soviet and Western observers have only recently begun systematically analyzing the effect of arrangements for publishing and distributing such documents on the exchange of information. Nonetheless, we are already in a position to pose some important questions and to suggest tentative answers about Soviet experience in this realm. One set of questions centers on the intranational transfer of information: Has the scale of serial and book publishing changed in recent years? How expeditiously do serials and books disseminate information? If there are impediments, what explains them? A second group of questions centers on the international transfer of information from foreign to Soviet scientists and engineers.² How much access do Soviet researchers have to Western books and serials? Are such materials significantly more difficult to consult than comparable Soviet works? How quickly are foreign research findings assimilated into published Soviet research? If there are bottlenecks in these international transfers, what causes them?

INTRANATIONAL INFORMATION TRANSFER

Publication Delays

The quantity of Soviet serial and book publications has risen substantially in recent years. Between 1965 and 1978 the number of book titles published annually in mathematics and the natural sciences jumped 41 percent (from 7,067 to 9,946), while the number of titles in technology, industry, and related areas rose 3 percent (from 27,021 to 27,935). In the same period the annual number of copies printed in mathematics and the natural sciences rose 9 percent, while the number in technology and related areas grew 21 percent.³ The increase in the publication of serials, particularly periodicals, has been much more rapid. Between 1964 and 1974 more than 100 new scientific and technical journals were established, and the share of the total new scientific and technological literature consisting of journals reportedly increased from 15 to 38.2 percent.⁴ As reflected by these aggregate indicators, the publication of books and articles seems to be flourishing.

The statistics conceal some difficulties, however, particularly in journal publication. A major problem is that there are frequently long delays in getting finished journal articles into print. Comparing a small number of major Soviet and Western journals in three scientific

¹A. I. Cherniy et al., "Chemistry in the USSR Academy of Sciences and Its Informational Needs," in *Informatsionnye problemy sovremennoy khimii* (Information Problems in Contemporary Chemistry), VINITI, Moscow, 1976, pp. 15-16; A. A. Belaya, "The Study of Scientific Communications in the Field of Fundamental Chemical Research," *NTI*, Series 1, No. 3, 1974, pp. 2-3; S. A. Dubinskaya, "A Study of the Information Requirements of Specialists Working in the Field of Chemistry," *NTI*, Series 2, No. 4, 1967, pp. 3-6, as cited by Nalimov and Mul'chenko, p. 165.

²Another aspect of international exchanges concerns information transfers from Soviet to foreign specialists. This subject deserves study, but it falls outside the scope of this report.

³Figures and calculations from *Pechat' SSSR v 1978 godu* (The USSR Press in 1978), Statistika Publishing House, Moscow, 1979, p. 25. All these figures cover nonserial brochures as well as books proper.

⁴V. Yezhkov, G. Martirosyan, and M. Chetyrkin, "An Important Part of Publicizing Scientific-Technical Achievements," *Kommunist*, No. 15, 1974, p. 120. The authors do not indicate the units in which this calculation was made.

fields during the late 1960s, Soviet observers found that the delays between receipt of an article and its publication were approximately twice as long for Soviet as for Western journals. In these three fields the publication times of Soviet journals sampled were consistently worse than the American, West German, and British times.⁵ Judging by the graphs contained in the Soviet report, the average time spent by a Soviet article in the offices of the journal which finally published it was roughly 12 to 15 months for the three fields. This unflattering picture is corroborated by a fuller study of a dozen Soviet and a dozen Western biological journals that were published in 1965. The average publication time for articles in the Soviet journals was 12.4 months, compared with 6.9 months for articles in the Western journals.⁶ In the late 1970s another study reported similar Soviet delays for a prominent journal in the emerging field of powder metallurgy. Over a span of five years, the average time between the submission and publication of articles had increased from 8.8 to 18.4 months.⁷ It should be noted that general conclusions drawn from these figures must be treated with care. To date no comprehensive statistics on publication lags have been compiled for a large number of Soviet journals ranging across many scientific fields, and until they are, we cannot be certain about the precise dimension of the problem.⁸ Nevertheless, the evidence accumulated thus far strongly suggests that the problem is very serious. Many Soviet observers firmly believe that publication lags in the USSR greatly exceed those in the West,⁹ and the available data are consistent with that view. A large study of U.S. scientists and engineers found that an average of 7 to 8 months elapsed between the submission and publication of their journal articles. This average is substantially below Soviet estimates of overall elapsed times in the USSR, which put the average period required for a journal to publish an article at about 12 months. Indeed, the real contrast is probably slightly greater than these figures indicate, since the American study counted from the completion of an article, not from its receipt by the journal that finally published it, and thus included the whole publication cycle of some articles that were rejected by one journal before being accepted by another.¹⁰

If the average Soviet delay is as large as suggested here, it is a major defect in the Soviet handling of scientific and technical information. It does not mean simply that Soviet researchers have suffered a one-time loss of 3 to 5 months in their competition with researchers of Western nations. It means that the whole Soviet R&D establishment is continually operating at a lower level of efficiency than would otherwise be possible, and that the loss of efficiency cumulates over time. Rather than being able to capitalize on the most recent domestic research in their fields, Soviet scientists must often duplicate or repeat that work because delayed publication keeps them from learning of it.¹¹ Although the amount of such

⁵Nalimov and Mul'chenko, pp. 153-155. The three fields were spectroscopy, metallurgy, and physical chemistry.

⁶L. L. Balashev, "Problems of Scientific Information in the Field of Biology," *NTI*, Series 2, No. 2, 1967, pp. 10-11.

⁷V. I. Yanovskiy, "A Quantitative Analysis of Publications on the Problems of Materials Science," *NTI*, Series 1, No. 2, 1978, p. 24.

⁸For a Western research team with the available time and money, a systematic study and international comparison would be quite feasible, since the necessary raw data are included in both Soviet and Western primary publications.

⁹In addition to the sources cited earlier in this paragraph, see G. V. Korsunskaya and T. S. Chernova, "Improving a Scientific-Technical Journal," in *Voprosy sovershenstvovaniya sistemy informatsionnykh izdaniy* (Problems of Improving the System of Information Publications), VINITI, Moscow, 1973, p. 114; G. M. Dobrov et al., *Organizatsiya nauki* (The Organization of Science), Naukova Dumka Publishing House, Kiev, 1970, pp. 95-96; and S. B. Zonn, "Current Problems of Scientific Periodicals," *VAN SSSR*, No. 10, 1978, pp. 80-81. According to Dr. Vladutz, virtually all the staff members of VINITI are convinced that the Soviet lags are considerably greater. His own guess is that the Soviet lag may be three months longer. (Telephone interview, August 1, 1980.)

¹⁰Garvey, Lin, and Tomita, Part III, pp. 209, 213. One-eighth of the articles examined were submitted to more than one journal before being accepted.

¹¹One might assume that the negative effects of delayed publication may be slightly mitigated by the availability of *The Registration Bulletin of Research and Design Projects*, the comprehensive list of research in progress mentioned above. However, in a telephone interview on August 1, 1980, Dr. Vladutz reported that rank-and-file scientists pay less attention to this source than do science administrators because it uses overly broad descriptive categories of little value to ordinary researchers (see Sec. V). In addition, some researchers probably resist sharing the details of their work with persons (particularly strangers) who use the bulletin as the basis of their inquiry. Instead, researchers prefer to publish first and then discuss their work.

duplication cannot be calculated, its cost in R&D efficiency must be quite high. Of course, the cost may be smaller in instances where preprints or invisible colleges allow prominent researchers to keep abreast of each other's work before publication. But there are strong reasons to believe that both preprints and invisible colleges are comparatively underdeveloped forms of information exchange among Soviet R&D specialists.¹²

What accounts for these publishing delays? One thought which comes to mind is the Soviet censorship. The government maintains a set of specialized censorship bodies to prevent the publication of research and engineering secrets, and it seems plausible that the time consumed in clearing articles for publication contributes to publishing delays.¹³ Censorship procedures are probably what some Soviet critics have in mind when they complain of the "significant period" spent in preparing the "accompanying papers" that must be approved before a scientific or technical article may be published.¹⁴ However, since the security screening of articles occurs at the writer's home institution before submission to a journal, the first phase of the censorship therefore cannot account for the long delays between submission and publication.¹⁵ Moreover, only a few days are required for a science journal's local censor to give final approval before an entire journal issue goes to press.¹⁶ Thus, even if the clearance process does slow the publication of articles, the delay seems to be relatively minor in comparison with the time lost at other stages.¹⁷

Refereeing may be another cause of delay. One Soviet scientist recently complained that outside refereeing of articles consumes too much time, particularly when qualified referees on new or esoteric subjects must be found. He added that delays also result from poor coordination among editorial workers.¹⁸ It is difficult to evaluate such judgments without more evidence. The Western journals that some Soviet critics hold up as models also rely on peer reviews of prospective articles, yet they apparently still process manuscripts rapidly. Perhaps the nature of Soviet reviews makes them more time-consuming than their Western counterparts. An emigre observer has suggested that Soviet journals rely more heavily than American journals on outside referees who occupy high administrative posts, rather than on referees who are distinguished only by their expertise.¹⁹ This suggestion dovetails with the conclusion of some Western scholars that the Soviet scientific community reserves greater status and initiative to science administrators than do Western scientific establishments.²⁰ More constrained by outside obligations than are full-time researchers, administrators may assign lower priority to their duties as referees and may take longer to perform them.

Editorial practices involved in the final selection of articles for publication may cause an additional bottleneck. Soviet manuscripts come to journals with the formal sponsorship of the

¹²The evidence for this proposition will be presented in a forthcoming report.

¹³For a description of these organizations by a former Soviet science journalist, see Leonid Vladimirov, "Glavlit: How the Soviet Censor Works," *Index on Censorship*, Vol. 1, No. 3-4, 1972, pp. 35-36.

¹⁴Nalimov and Mul'chenko, pp. 165-166.

¹⁵For each proposed publication, the director of the establishment appoints a three-person commission to prepare a Certificate of Expert Evaluation (*Akt ekspertizy*). This commission consists of regular scientists and/or engineers. The guidelines for their work, in cases where they are in doubt about the permissibility of publication from a security point of view, are provided by the First Department (i.e., secret police office) of the institution. The censorship regulations governing science and technology are in the possession of this department. (From a telephone interview with Dr. Vladutz on August 1, 1980.) Compare the similar procedures for clearing a foreign scientific lecture as described by Zhores Medvedev, *The Medvedev Papers*, Macmillan, London, 1970, p. 60.

¹⁶Telephone interview with Dr. Vladutz, August 1, 1980.

¹⁷Ibid. Dr. Vladutz estimates that such approval takes one or two weeks under ordinary circumstances. It would be useful to survey emigre Soviet scientists from various fields to see if the time loss is roughly the same across R&D specialties.

¹⁸Zonn, pp. 80-81.

¹⁹Telephone interview with Dr. Vladutz, August 1, 1980.

²⁰See especially Thane Gustafson, "Why Doesn't Soviet Science Do Better Than It Does?" in Linda L. Lubrano and Susan Gross Solomon (eds.), *The Social Context of Soviet Science*, Westview Press, Boulder, Colo., 1979, pp. 31-68.

author's institution. To avoid offending powerful organizational sponsors, journal editors may spend an excessive amount of time working with the authors of weak manuscripts rather than reject the manuscripts outright, and may thereby slow the whole editorial process.²¹

Insufficient Number of Serials

However important these sources of delay, another is more telling: an insufficiency of serials large enough to publish all the findings of the Soviet R&D community quickly. The USSR has more scientists and engineers engaged in R&D than any other country in the world. These researchers generate large amounts of material that they wish to have published.²² Yet the number of Soviet serials is disproportionately small by international standards. In 1961 a world census of scientific and technical serials showed that the USSR had about 10 percent more titles in the exact sciences than did the United States.²³ However, the USSR had a drastically smaller number of technical serials. For every serial in the natural and physical sciences, it had only 2.1 technical serials; in Japan the ratio was 3:1, in France 4:1, and in the United States 7:1.²⁴ Taking into account both scientific and technical serials, the USSR had slightly more than one-third as many serials as did the United States, the only country approaching the USSR in the scale of its R&D establishment. Moreover, the number of Soviet serials was slightly below the totals for most other developed countries. These figures suggest that in 1961 the preconditions existed for heavy overloading and large editorial backlogs in the Soviet scientific and technical publishing network.

The state of Soviet scientific publishing has caused concern among the country's top science administrators. In 1967 the leaders of the Academy sparred publicly with the chairman of the State Committee on the Press over this matter. A vice president of the Academy contrasted the sharp growth in the number of research workers with the decline in the total number of copies of scientific books published in recent years. The president of the Academy remarked that the growth of the network of scientific journals was too slow and asserted that the lag was contributing to the delay in publishing articles that ought to appear on a rush basis. In response to the demand for more books, the chairman of the State Committee maintained that the Academy's publishing house should expend its stocks of paper "economically" and should not repeat the unjustified increases in the size of books and editions that had occurred in the past. Although he did not reply directly to the president's appeal for a rapid expansion of the journal network, the spirit of his remarks was clearly against a major increase in the scale of scientific publishing.²⁵

Since the 1960s, the volume of scientific and technical publishing has grown somewhat. However, it is unlikely that the increases have materially reduced the obstruction to the flow of information. One reason is that the number of researchers has continued to climb rapidly (from about 900,000 to about 1,300,000 between 1970 and 1978), making some expansion of the publications network necessary simply to keep publishing delays from worsening.²⁶ Another reason is that virtually all the journal growth seems to have occurred within the

²¹Telephone interview with Dr. Vladutz, August 1, 1980.

²²There is a strong emphasis on publication among Soviet researchers. The professional need to publish begins even before a young scientist obtains a doctoral degree, since it is necessary to have published a certain number of articles in order to obtain the degree.

²³Estimated from a graph in Charles M. Gottschalk and Winifred F. Desmond, "Worldwide Census of Scientific and Technical Serials," *American Documentation*, Vol. 14, No. 3, July 1963, p. 191.

²⁴Calculated from the figures in *ibid.*, exclusive of serials in medicine and agriculture. The ratio for German-language serials (2.5:1) is a special case, since the authors' data combine West German and East German publications.

²⁵"Improving the Work of the Nauka Publishing House," *VAN SSSR*, No. 2, 1967, pp. 8-13.

²⁶Central Statistical Administration, USSR, *Narodnoye khozyaystvo SSSR v 1978 g. statisticheskiy yezhegodnik* (The National Economy of the USSR in 1978, Statistical Yearbook), Statistika Publishing House, Moscow, 1979, p. 89.

USSR and republican academies. Between 1961 and 1976 these academies published 109 new journals.²⁷ This increase is rather deceptive, however. The growth of the network of academy journals was considerably more rapid in the 1960s than in the first half of the 1970s,²⁸ and some reports suggest that during the late 1960s the expansion had only a marginal effect on publication delays.²⁹ Moreover, the network of academy journals grew partly at the expense of irregular serials (the "sborniki" and "trudy"), which are published by individual institutes and are not officially classified as journals. For example, when the USSR Academy set up 82 new journals, it shut down roughly 400 of these irregular serials.³⁰ The shift to journals was doubtless a blow to more efficient information exchange.³¹ But the cutback of irregular serials indicates that not all of the roughly 100 new journals created from 1961 to 1976 can be counted as a net increase in the publishing capacity of the serials network as a whole. Finally, the number of journals put out by Soviet industrial ministries remained virtually unchanged, even though the number of technical serials was disproportionately low to begin with.

Probably because of persistent delays in publishing research findings, the scale of scientific publishing has remained a point of tension between the scientific establishment and the government. Although the government wants rapid scientific and technical progress, it has other uses for the finite resources of the publishing sector, particularly the restricted amount of paper available. Nonscientific publications, such as political literature, are strong competitors for paper, especially because some political officials who allocate resources appear not to appreciate the importance of publication to the advancement of science and technology. In 1975, for example, the CPSU Central Committee issued a resolution that called for a sharp reduction in publishers' paper consumption and reportedly necessitated a reduction in the average length of scientific books.³² In 1979 the Central Committee adopted another resolution, "On the Rationalization of the Edition Sizes and Reduction of the Number of Periodical Publications," calling for more efficient use of the limited paper supply and urging journals to purvey information more efficiently. Referring to this decree, the chairman of the State Committee on Publishing indicated that about 300 journals were reduced in size in 1979, ostensibly on a temporary basis. The 11,000 tons of paper thus saved were channeled to popular journals, especially periodicals for children.³³ The chairman, noting that the Central

²⁷Ye. S. Likhtenshtein, "60 Years of Scientific Book Publishing and Ways of Increasing Its Effectiveness," *Kniga: issledovaniya i materialy* (Research and Materials on Book Publishing), sb. 35, Kniga Publishing House, Moscow, 1977, p. 58.

²⁸Between 1961 and 1971, the number of journals (excluding the social sciences) grew by 73; between 1971 and 1976, the number increased by 14. (Calculated from *ibid.*) The annual rate of creation of new journals in the 1970s was thus only about a third of the rate in the 1960s. After 1971 the rate of growth in the total number of pages of journal copy published by the academies similarly dropped to half the 1960s rate. (Calculated from *ibid.*)

²⁹Between 1965 and 1967 the Ukrainian Academy, the most prestigious of the republican academies, expanded its complement of journals from 19 to 26 and increased the size of several of the original 19. Despite these changes, publication delays reportedly declined only slightly. In six journals they still averaged about 1.5 years. In four others (three of them scientific), the delays reached 2 to 2.5 years. Three of the new journals had delays averaging 1.5 years. (Dobrov et al., pp. 95-96.) The authors give their general conclusion and the information just cited but unfortunately offer no overall statistics on delays for the middle or end of the decade.

³⁰Gregory Walker, *Soviet Book Publishing Policy*, Cambridge University Press, Cambridge, 1978, p. 113; Likhtenshtein, pp. 63-64.

³¹Publishing irregular serials has certain advantages: (1) the decision to publish them does not require the permission of the CPSU Central Committee (which is required to establish a journal proper); (2) no minimum number of copies is required for each issue; and (3) the publishing institution has a guaranteed outlet for the work of its researchers, including those who are seeking doctoral degrees and must publish to obtain the degree. (Telephone interview with Dr. Vladutz, August 1, 1980.) The disadvantages of irregular serials are that (1) the quality of articles tends to be highly uneven, partly for want of outside refereeing, and that (2) each of the serials covers such a miscellany of subjects that specialized readers and indexing services tend to ignore them.

³²Likhtenshtein, p. 60. The text of the resolution has not been published.

³³B. Stukalin, "A Minimum of Paper—A Maximum of Information," *Literaturnaya Gazeta*, No. 51, December 19, 1979, p. 11. Stukalin also indicated that in 1978-1979 the effort to conserve paper had reduced secondary publications in science and technology by 8000 publishers' signatures (*uchetno-izdatel'skikh listov*), or about 85,000 printed pages.

Committee resolution had advised scientific bodies to make greater use of alternatives to publication, complained that editorial boards in the USSR and republican academies, as well as those in the Ministry of Health and the Academy of Medical Sciences, had made insufficient use of these alternatives.³⁴

Late in 1978, while the cutbacks in journal publication schedules must have been under deliberation, the house organ of the USSR Academy printed an article that implicitly advocated a very different policy. Although the editorial boards of scientific journals were the professed target of the author's remarks, it seems likely that top-level officials in charge of publishing were his latent target. The writer assailed "the current practice of massive rejection of manuscripts" by scientific journals and asked rhetorically whether "the massive destruction of scientific product" that this practice entailed was justified by the resulting savings in paper. His answer was clearly "no." Scientific publishing, he suggested, was currently like a factory that preserves only three of every ten cars it makes because it has no warehouse in which to store them.³⁵ Citing the experience of an American journal, *Physical Review Letters*, he argued that quadrupling the journal's size had not resulted in a decline in the quality of its articles but had contributed to its emergence as a top-flight journal.³⁶ He obviously meant the case to illustrate his arguments against the state policy for scientific publishing.

A shortage of specialized serials impedes the transmission of unorthodox ideas and information, particularly in emerging disciplines and subdisciplines. The establishment of separate journals aids the coalescence of major new research fields.³⁷ It fosters contacts among researchers interested in a new field and allows them to apply their own paradigm of what constitutes good research and satisfactory evidence. Serious external constraints on the total number of scientific and technical journals are likely to inhibit this pooling of new ideas and information.

In an article in the house organ of the USSR Academy, an information specialist asserted that a number of Soviet scientific fields exhibit "definite preconditions for excessive paradigmatic pressure."³⁸ By this he meant that the organizational structure of authority in these disciplines gives conventional researchers too much power to suppress unconventional ideas. Basing his analysis partly on his experience as an editor-referee, he maintained that the impulse to screen out unorthodox ideas should be reduced. Arguing that one means of achieving greater intellectual openness among scientists would be "a certain superfluity of journals," he stated that the lack of a ramified network of Soviet journals in several specialties has slowed the development and dissemination of innovative research. Although he did not suggest that the shortage of publishing outlets is equally serious within all specialties, he obviously felt that the problem is generally worse in the USSR than in some other countries.³⁹ To illustrate the difficulty, the author chose *Factory Laboratory*, a journal

³⁴The main option was to store unpublished manuscripts in special document depositories. (This subject is treated in the following section.) The chairman also stated that the resolution authorized an experiment involving the announcement and distribution of individual copies of scientific articles in advance of their appearance in journals; the experiment was begun with the hope that many readers would switch from journal subscriptions to selective purchasing of articles (ibid.).

³⁵M. K. Petrov, "Editorial Practice: Objectivity or Voluntarism?" *VAN SSSR*, No. 11, 1978, p. 78.

³⁶Ibid. Petrov began his article by citing the rejection rates for American journals (which show high rates of rejection in the social sciences and humanities and relatively low ones in the natural sciences) as examples of wasteful editorial practices. He clearly implied that Soviet rejection rates, for which no statistics have ever been published, were at least equally bad. He concluded by choosing an American scientific journal as a model of the solution to Soviet publishing bottlenecks.

³⁷Warren O. Hagstrom, *The Scientific Community*, paperback ed., Southern Illinois University Press, Carbondale, Ill., 1965, pp. 210-211.

³⁸V. V. Nalimov, "The Problem of Man in Contemporary Science," *VAN SSSR*, No. 6, 1979, pp. 65-67.

³⁹Ibid. Nalimov cited three disciplines that completely lack their own journals: logic, mathematical statistics, and interpersonal psychology. Western political scientists may be interested to note that he plainly meant his criticisms to apply to the social as well as the natural sciences.

intended to link science and production. The shortage of such journals in the USSR, he held, prevents the publication of many useful articles; moreover, the articles printed in *Factory Laboratory* are often so condensed that factory R&D personnel have trouble understanding them. The author's choice of a technical journal to illustrate this problem is interesting in light of our earlier analysis of the disproportionately small number of Soviet technical journals compared with scientific ones. This disparity led us to expect that the technical publications linking scientists with engineers might pose large obstacles to information transfer.

Such views have won limited support from some publishing officials. Writing in 1974, one top specialist on scientific and technical publishing noted that although a large number of new journals had been founded during the last decade, the majority of branch journals had been set up 20 to 30 years earlier, before the appearance of R&D fields ranging from technical cybernetics to nuclear energy. As a result, he said, it was necessary to create some additional branch journals, to make some changes in the structure and profile of those already in existence, and to abolish others. Calling for a reconsideration of the administrative subordination of such journals (then as now primarily under the industrial ministries), the official advocated creating an association which would publish many different journals. The implication seemed to be that branch journals were unreceptive to new scientific and technical trends because they were controlled by ministerial bureaucracies occupying a fixed economic and technological domain.⁴⁰ Thus, the publishing official implicitly agreed with the scientific critics who found that the journal system was too rigid and unreceptive to new ideas. However, he preferred to add some journals while eliminating others, rather than to enlarge the journal network as a whole.

Inflexible Response to Reader Demand

Aside from publishing delays and barriers to the dissemination of information in new R&D specialties, another difficulty of scientific and technical publishing is matching the quantities of books and journals to reader demand. Scientific and technical textbooks are in short supply. In 1974, library suppliers were able to satisfy only 60 to 70 percent of the book orders (primarily for textbooks) from higher and secondary specialized institutions for books.⁴¹ The sparse available data suggest that professional readers also have trouble buying needed materials. A survey reported in 1972 indicated that only 13.4 percent of the specialists queried could get all the books they wanted from bookstores; 64.3 percent could satisfy some of their requirements; and 22.1 could purchase none of the books they wanted.⁴² Part of this shortage must stem from the general reduction in the average press-run for scholarly books in science and technology, which dropped from 5100 copies in 1955 to 1416 copies in 1975.⁴³ Another cause is that bookstores, only marginally interested in books published in such small editions, tend not to order them; nor do the stores do market research to ascertain local demand.⁴⁴ Similar problems reportedly affect scientific journals, which seem to be published in considerably smaller quantities than are their American counterparts and may therefore be harder to acquire.⁴⁵ Publishing houses print only enough copies to meet subscription demand. As a result, single copies are unavailable for purchase on a nonsubscription basis.⁴⁶

⁴⁰Yezhkov, Martirosyan, and Chetyrkin, pp. 119-120.

⁴¹Walker, p. 109.

⁴²Ibid.

⁴³Ibid., pp. 87, 112.

⁴⁴V. Yezhkov, "The Technical Book: Demand and Propaganda," *V mire knig*, No. 4, 1974, pp. 35-37.

⁴⁵In 1975, the average circulation of a sample of 20 American scholarly journals in the physical sciences was 6030. Fritz Machlup, Kenneth Leeson and Associates, *Information Through the Printed Word*, Praeger, New York, Vol. 2, 1978, p. 192. For a sample of 42 Soviet journals in the physical sciences, the average 1976 circulation was 2114; the average of the 20 journals with the largest circulation was 3037. (Calculated from the publication data in each of the journals listed in the Appendix.) If the American average is taken as a standard, the Soviet journal runs appear to be small. However, part of the discrepancy between American and Soviet average circulation may be accounted for by different levels of foreign (as opposed to domestic) demand for the journals of the two countries.

⁴⁶M. S. Rabinovich, "Several Problems of a Scientific Journal," *VAN SSSR*, No. 9, 1979, pp. 59-61.

Geographic Differences

These difficulties in meeting the demand for scientific and technical literature may explain some important geographic differences in the transfer of published information inside the USSR. In 1975, O. M. Sichivitsa examined the citation patterns in Soviet natural scientific and technical journals published during the preceding 10 years. She divided the journal sample into those published in three major science centers and those published in outlying cities and republics.⁴⁷ Juxtaposing the ages of the sources cited in these two groups of journals, she found that articles in journals from the outlying areas drew much more heavily on "archival" research—i.e., research published more than five years previously—than did journals from the major science centers.⁴⁸ Despite certain methodological limitations, in all likelihood her findings do indicate a real geographic difference in information utilization.⁴⁹ Of course, the underutilization of the most recent research may also be attributed to a concentration of less-energetic researchers in the outlying areas. But even if such a differential in motivation is a contributing factor, the greater difficulty of obtaining published primary documents outside major research centers must also be an important cause. Outside the major centers, the specialist book market is less predictable, and booksellers are less willing to order specialized books for fear of having to remainder them. The libraries in these regions, which already have less comprehensive collections, encounter more trouble purchasing Soviet scientific books.⁵⁰ In addition, the interlibrary loan service has limitations that keep its users from obtaining the latest monographs and journal articles.⁵¹

INTERNATIONAL INFORMATION TRANSFER

References to Foreign Publications

Because foreign researchers generate a large amount of information offering great potential benefit to Soviet science and technology, the way the Soviet system promotes or retards the international transfer of information has no less bearing on the success of Soviet R&D than does the intranational exchange of information. What kind of access to foreign books and serials does the Soviet system provide? How quickly do Soviet researchers learn of valuable foreign R&D, and how widely is such information disseminated inside the USSR?

Let us first consider how long it takes for scientists and engineers to learn of the contents of foreign books and serials. While the data are not sufficient to allow categorical conclusions, they strongly suggest that the information system works fairly well in some specialties but very badly in others. A study of selected Soviet journals for the mid-1960s showed that the

⁴⁷Thirteen of the fourteen central journals were published in Moscow or Leningrad; one was published in Novosibirsk. The noncentral journals were published in Tula, Kazakhstan, etc.

⁴⁸O. M. Sichivitsa, *Mobil'nost' nauki* (Mobility of Science), Volga-Vyatskoye Book Publishing House, Gorkiy, 1975, pp. 215-220.

⁴⁹One limitation is that all of Sichivitsa's central publications are published by the Academy of Sciences or by universities, whereas some of the noncentral publications are issued by pedagogical and polytechnical institutions. Hence some of the difference may be institutional rather than geographic in origin. A second limitation is that the author bases her study on place of publication rather than place of research. Most of the research published in the science centers is performed there, and most of that published in the outlying areas is done outside the centers, but the correlation is not perfect. Finally, the author includes a couple of Moscow and Novosibirsk journals in her noncentral sample. But the total number of journals in this category is so large that their inclusion could not account for the regional differences.

⁵⁰"Speeches of Academy Members," *VAN SSSR*, No. 6, 1978, p. 38.

⁵¹Knyazeva, pp. 65-67; G. I. Gol'dgamer, "The Status and Prospective Development of Reference-Information Holdings," *NTI*, Series 1, No. 10, 1979, p. 14.

foreign sources cited in physical and analytical chemistry were on an average only about one-third and one-half years older, respectively, than were the domestic sources cited.⁵² These lags are partly attributable to the international mails, especially for journals mailed from the Western hemisphere. In general metallurgy, however, the foreign sources cited were almost two and a half years older than the domestic ones, and in optics the discrepancy reached a remarkable four and a half years.⁵³ A study of a major electrical engineering journal found that the foreign sources cited were on an average 4.6 years older than the domestic sources.⁵⁴ An examination of more recent Soviet publications in powder metallurgy revealed a similar picture. The median age of the foreign sources cited was three years greater than that of the domestic sources.⁵⁵ Together with the qualitative evidence examined below, these figures suggest that Soviet specialists in a wide range of fields encounter serious barriers to the timely acquisition of foreign scientific and technical publications.

New or old, foreign publications play a larger role in the work of metropolitan R&D institutions than in the work of institutions located in less prominent cities. Sichivitsa found that research published in three major Soviet science centers cited 63 foreign sources for every 100 domestic ones, whereas research published in outlying cities cited only half as many: 30 foreign for every 100 domestic ones.⁵⁶ These findings suggest either that less foreign information reaches R&D establishments in the outlying areas, or that some of it reaches these institutions by a delayed two-step process, i.e., after being assimilated into the writings of researchers published in the major centers. The remainder of this section considers which features of the Soviet information system may contribute to these geographic differences in the utilization of foreign sources, as well as to the general Soviet lag in gaining access to such sources.

Acquisition of Foreign Publications

Given the Soviet determination to promote rapid scientific and technological advance, one would expect the government to purchase virtually all the foreign literature available, but this is not the case. In the late 1960s, two top officials of VINITI estimated that the country was purchasing only about half the foreign scientific and technical books sold abroad each year.⁵⁷ Despite the officials' hopes of changing this situation, it persisted in the 1970s. In 1973—the last year for which Soviet statistics are available—Soviet libraries received a total of 23,312 foreign books in the natural sciences, technology, medicine, and agriculture.⁵⁸ This compares with about 46,000 books published annually in these fields during the early 1970s by foreign countries with significant R&D establishments.⁵⁹

The same Soviet experts suggested, albeit with rather imprecise supporting data, that in the late 1960s Soviet libraries acquired only about half as much of the world output of scientific and technical periodicals as did the British Lending Library. Given the difficulty of

⁵²Nalimov and Mul'chenko, p. 156.

⁵³Ibid.

⁵⁴Dobrov et al., p. 102.

⁵⁵Yanovskiy, p. 25. This study was based on a Soviet journal different from the one used to analyze general metallurgy in the 1960s.

⁵⁶Sichivitsa, p. 220.

⁵⁷A. I. Mikhaylov and R. S. Gilyarevskiy, "Unresolved Problems of Scientific Libraries," *VAN SSSR*, No. 9, 1967, p. 26.

⁵⁸*Svodniy byulleten' novykh inostrannykh knig v bibliotekakh SSSR: Yestestvenniye nauki, meditsina, sel'skoye khozyaystvo, tekhnika* (Summary Bulletin of New Foreign Books in USSR Libraries: Natural Sciences, Medicine, Agriculture, Engineering), No. 6, 1973, p. 219.

⁵⁹Calculated from the tables in *Statistical Yearbook, 1974*, UNESCO, Paris, 1975, pp. 711, 718, 722, 731-736. The countries included in this calculation are Canada, the U.S., the U.K., the major countries of Western and Eastern Europe, Israel, Japan, and India. Except in a few cases where the only available data include pamphlets, second editions, and translations, the figures used exclude these materials.

defining the terms "serial" and "periodical," this claim is harder to verify, but it appears to hold both for the 1960s and for the 1970s. The lowest, most careful Western estimate puts the total world output of scientific and technical serials at about 26,000 in the mid-1960s.⁶⁰ Presumably this figure had risen somewhat by 1972 when, according to Soviet data, Soviet libraries and VINITI received an annual total of 11,273 foreign serial titles in science and technology.⁶¹ In 1971 the Soviet Union's own complement of journals, proceedings, and bulletins in these fields totaled 3241.⁶² If this figure is subtracted from world output, the logical conclusion is that the USSR was forgoing the acquisition of at least 11,000 foreign scientific and technical serials in the early 1970s.

The principal cause of this situation is a persistent Soviet shortage of hard currency, combined with a belief by those who allocate the available currency that foreign goods and physical technology are more important than a complete stock of foreign scientific and technical publications. It is a significant historical fact that the Soviet academies' acquisition of foreign scientific literature was sharply centralized in 1934, in the wake of a major hard-currency crisis.⁶³ The controls have continued to the present day and, more important, so has the rationing mentality that originally prompted them. The share of Soviet hard-currency outlays allocated to foreign printed matter is minuscule, but the financial authorities have nevertheless resisted any dramatic increase in spending for Western scientific literature.⁶⁴ The director of VINITI and several scientists have noted that the stock of hard currency for purchasing foreign scientific and technical literature has not risen since the early 1970s, while the price of that literature has risen dramatically, making the acquisition of foreign publications increasingly difficult.⁶⁵ Consequently, it has been necessary to cut some subscriptions. In 1974 the libraries of the USSR and republican academies subscribed to 26,111 sets of foreign journals (including duplicates) and 29,100 handbooks and monographs. By 1977 this figure reportedly dropped to 24,812 journals and 20,000 handbooks and monographs.⁶⁶

In one sense, the authorities who allocate hard currency may be right in restricting the total number of foreign titles purchased. The lack of access to every conceivable foreign publication is undoubtedly much less injurious than the figures given earlier suggest. A substantial body of citation research shows that the bulk of the material that R&D specialists find useful comes from a relatively small fraction of the total available literature.⁶⁷ Hence, as long as Soviet libraries and information agencies select and review their foreign purchases carefully, as they are increasingly striving to do, the country can purchase only half the foreign scientific and technical titles available and still obtain far more than half the

⁶⁰K. P. Karr, "Estimates of the Number of Currently Available Scientific and Technical Periodicals," *The Journal of Documentation*, Vol. 23, No. 1, March 1967, pp. 110-116. Despite the title, the criteria used in this count did not require regular periodicity for a series to be included.

⁶¹*Svodniy katalog inostrannykh nauchnykh periodicheskikh izdaniy, postupivshikh v biblioteki SSSR: Yestestvenniye nauki, meditsina, sel'skoye khozyaystvo, tekhnika*, 1972 (Union Catalog of Foreign Scientific Periodical Publications Available in USSR Libraries: Natural Sciences, Medicine, Agriculture, Engineering, 1972), Kniga Publishing House, Moscow, 1974, p. 816. Despite its title, the introduction to this volume states that it covers both periodical and continuing (i.e., nonperiodic) publications; hence I have described them as serials.

⁶²*Bol'shaya sovetskaya entsiklopediya*, 3d ed., Vol. 9, p. 249.

⁶³A. N. Kruglakovskiy, "The Experiment of a Centralized Service of Academic Libraries with a Natural-Technical Profile in the USSR Academy of Sciences," *Sovetskoye bibliotekovedeniye*, No. 2, 1973, pp. 88-89; N. I. Maloletova and M. S. Nyznikov, "Several Issues in Improving the Centralized Acquisition of Foreign Literature for the Scientific Establishments of the Ukrainian Academy of Sciences," *Opyt tsentralizatsiy bibliotekhnogo dela: Sbornik nauchnykh trudov* (The Centralization of Library Management: A Collection of Scholarly Studies), No. 1, 1977.

⁶⁴In 1979, Soviet spending on all forms of printed matter from the U.S., U.K., France, and West Germany totaled a mere 6.4 million rubles. Calculated from *Vneshnyaya torgovlya SSSR za 1979 g.* (Foreign Trade of the USSR in 1979) (Moscow, 1980), p. 97. I am indebted to Nancy Nimitz for calling this fact to my attention.

⁶⁵"Speeches," p. 37; Rabinovich, p. 62; "Management," p. 37.

⁶⁶"Speeches," p. 37.

⁶⁷For Soviet evidence, see Dobrov et al., p. 103. There are numerous similar Western studies.

genuinely useful information generated abroad. This is not to deny that the relatively low level of Soviet acquisitions entails some loss. But the critical aspect of documentary access to foreign science and technology has less to do with buying all the publications available than with purchasing the best and distributing them efficiently inside the country. Deficiencies in the latter area, not the former, primarily account for delays in citing foreign sources and for the tendency to use them less in research conducted outside the main scientific centers.

Dissemination of Foreign Publications

The dissemination of foreign books and journals inside the USSR is shaped by several factors. From the early 1950s until 1974, the regime relied on two methods of disseminating such materials. Under one method, books and some periodicals were purchased and distributed directly to Soviet users. The political screening of these documents was done by censors connected with the central post office.⁶⁸ Under the second method, VINITI subscribed to single copies of a large volume of scientific and technical periodicals. After the resident secret police officials had excised any material suspected of being subversive, VINITI pasted up each number of the journal, reproduced it by an offset process, and distributed these cover-to-cover reproductions to subscribing organizations.⁶⁹ In 1970 VINITI reproduced about 500 titles in this manner.⁷⁰ The arrangement was used both to avoid contaminating Soviet specialists with "subversive" Western ideas and to conserve scarce hard currency for other uses. According to Soviet critics of the information system, many foreign journals, including some of the most important, reached researchers in the form of such copies; and the duplication process required, on the average, "not less than six months" extra.⁷¹ Copying of this kind was better than nothing, but it undoubtedly contributed substantially to the lags in disseminating foreign scientific and technical information.

Since 1974 a combination of circumstances has changed this distributing arrangement, apparently for the worse. In 1974 the USSR subscribed to the international copyright convention, which obligates Soviet agencies not to reproduce entire foreign publications without the consent of their publishers. VINITI therefore ceased producing its cover-to-cover copies of foreign journals, except for the isolated cases in which it could reach agreement with the publisher to continue the practice.⁷² The elimination of these reproductions exerted additional pressure on the Soviet stock of foreign serials in the original, since more researchers now needed to use them. Meanwhile, however, the price of foreign publications climbed sharply, and the supply of foreign currency available for subscriptions did not keep pace. It would be interesting to know whether Soviet scientists anticipated this problem before the signing of the copyright convention and whether they were assured that some hard-currency royalties

⁶⁸On this aspect of the censorship, see Medvedev.

⁶⁹*Resheniya partii i pravitel'stva po khozyaystvennym voprosam* (Party and Government Decisions on Economic Issues), Politizdat, Moscow, Vol. 6, 1968, p. 272; telephone interview with Dr. Vladutz, July 25, 1980.

⁷⁰Medvedev, p. 124. Note that the number of titles reproduced and the number of foreign subscriptions that the Soviets forgo are two entirely different categories. Reproduction of one title may allow the regime to cancel hundreds or thousands of foreign subscriptions to that journal.

⁷¹Nalimov and Mul'chenko, p. 164.

⁷²"Speeches," p. 37; telephone interview with Dr. Vladutz, July 25, 1980. The Soviets were able to reach such an agreement with *Science* magazine. According to Dr. Robert Ormes, the managing editor of *Science*, it calls for the USSR to pay the publisher a ten percent royalty for each subscription to the Soviet version, taking the Soviet price (converted into dollars) as a base. The Soviets report that between 700 and 800 of these subscriptions are sold per year, and they pay an annual royalty of about \$5,500 to *Science*. (At current foreign subscription rates, 800 direct institutional subscriptions to *Science* would cost roughly \$72,000.) According to Dr. Ormes, Soviet representatives contacted several other professional societies and a large number of journals with similar proposals. As far as he knows, none of these was accepted. (Telephone interview, February 6, 1981.) The reproductions continue to be censored. See *Science*, Vol. 197, August 12, 1977, pp. 646-647, for details.

from the sale of Soviet publications abroad would be funneled into new subscriptions to foreign journals. At any rate, no additional hard currency was provided.

Instead, many subscriptions to foreign journals were cut and a new emphasis was placed on concentrating foreign periodicals in a small number of central libraries. The effort to reduce duplicate subscriptions, already under way in the early 1970s, was intensified. The main library of the USSR Academy, which handles foreign acquisitions for 150 specialized libraries within the Academy and 30 outside it, began to refuse a greater proportion of their requests for subscriptions to foreign journals, cutting more than 900 subscriptions between 1975 and 1977.⁷³ Such reductions hit the libraries of the republican academies and of individual institutes especially hard. According to a member of the Academy, some libraries virtually lost the ability to purchase foreign books, and in some the number of foreign journals received dropped by almost one-third.⁷⁴ In 1979 a scientist from the Lebedev Physics Institute, one of the most prominent physics establishments in the USSR, commented that rising prices and lack of additional hard currency were forcing the institute to choose among subscriptions to foreign journals; he labeled this situation "dangerous."⁷⁵ A vice-president of the Academy remarked that the supply of foreign journals was insufficient, especially for rank-and-file researchers, and said that it was necessary to find a "technical solution" to this problem.⁷⁶

As a possible technical solution, science administrators originally envisaged increasing the capacity of libraries and information organs at all levels to copy individual articles in response to custom orders from scientists and engineers. This kind of copying does not violate the provisions of the international copyright convention. Because filling custom orders was more difficult administratively and technically than mass-producing copies of whole journals, the USSR and republican academies earmarked special funds in 1975 to purchase more copying equipment to handle this load. The equipment was not purchased, however. The Presidium of the USSR Academy was said to lack the money—most likely hard currency—to buy even the spare parts and materials needed to keep the existing copying equipment running. As a result, many libraries of the republican academies nearly ceased copying articles in 1979, and the national academy's three largest libraries, whose copying effort remained "extremely limited," were unable to take up the slack.⁷⁷

Judging by indirect evidence, the persistent lack of copying technology must have had two consequences, both closely related to characteristics of the information system which we noted earlier. First, it probably made foreign publications even less accessible, relative to domestic publications, than in the 1960s. An analysis of the requests for copies of journal articles submitted to VINITI early in 1974 showed that the demand for copies of foreign articles was disproportionately heavy. Fully 81 percent of the journals from which copies were sought were printed in English, German, or French; only 5 percent were printed in Russian.⁷⁸ The overloading of the copying system must therefore have slowed the dissemination of foreign information more than domestic. Second, the new pressures on the country's copying capacity probably hurt outlying research and engineering establishments more than those located in metropolitan centers. At mid-decade, a large survey of chemists found that 53 percent of the

⁷³Kruglakovskiy, pp. 88-89. The same author says that the level of *ekzempliarnost'*, or duplication, of foreign journal subscriptions was reduced 70 percent between 1972 and 1977. It is not clear how he calculated this figure, which apparently applies only to the library's own holdings.

⁷⁴"Speeches," p. 37.

⁷⁵Rabinovich, p. 62.

⁷⁶"Management," p. 43.

⁷⁷"Speeches," pp. 37-38. According to an article called to my attention by Nancy Nimitz, domestically produced copying machines are plagued by poor performance and a shortage of supplies. So serious are these problems that many potential buyers, despite a great shortage of copiers, resist buying the Soviet models. See "Razvyazaniy uzel" (An Untied Knot), *Sotsialisticheskaya industriya*, July 25, 1976.

⁷⁸The requests analyzed were within two sectors. See Ye. S. Kashafutdinova, F. Ye. Grishina, and M. N. Myal'dizina, "An Analysis of the Demand for Journals in Electrical and Power Engineering from the Collection of the Information-Reference Center of VINITI," *NTI*, Series 2, No. 8, 1975, pp. 8-9.

respondents outside Moscow and Leningrad, as opposed to only 22 percent of the respondents in those cities, relied on copies of publications obtained from VINITI.⁷⁹ As the supply of originals dwindled and the copying system failed to meet the new demand for custom copies, the gap in access to foreign science and technology between central and peripheral researchers in all likelihood widened.

⁷⁹Cherniy et al., p. 21.

V. UNPUBLISHED REPORTS AND DISSERTATIONS

Unpublished reports and dissertations contain a considerable amount of information that may be useful if readers can locate and acquire the documents. Most field surveys indicate that although Soviet scientists accord such materials comparatively low priority in information searches, design and production engineers assign them a more prominent place.¹ Since the mid-1960s the USSR has gradually improved the level of bibliographic control over these documents and has increased their accessibility. As in Western industrial societies, the system for indexing and disseminating unpublished documents is still underdeveloped by comparison with the older arrangements for managing published sources, but it has already assumed impressive proportions. At least three all-union information organizations—VNTITs, VIMI, and VINITI—play a role in making these documents available.

According to published descriptions, VNTITs (the All-Union Center of Scientific and Technical Information) seems to have the most important part in organizing unpublished documents. VNTITs was set up in 1967 to catalog every unclassified research and design project in the country, from the time the project is first included in a research plan until it is completed.² Dissertations also fall within its terms of reference. Once a project is finished, VNTITs is supposed to receive a copy of the final research report (*nauchno-tekhnicheskii otchet*). It microfilms these reports, many of them over 100 pages long,³ and furnishes copies to interested organizations on request. By 1971 VNTITs had accumulated more than 100,000 microfilmed reports and dissertations, and by 1975, 550,000. At mid-decade its records covered more than a million past and present R&D projects.⁴ As indicated in Section III, VNTITs publishes listings of these research projects by topical area and issues abstracts of the incoming reports. From 1973 through 1975 more than 3500 institutes, design bureaus, and enterprises subscribed to these services, and in one year they received more than 13 million pages of copies of reports. By 1979 the number of such subscribers had risen to about 14,500.⁵

VNTITs also distributes information concerning unpublished reports and dissertations from Eastern Europe. The compilation of abstracts of East European research reports is formally the domain of the Moscow-based International Center of Scientific and Technical Information (MTsNTI), created in 1969 under the auspices of the Council of Economic Mutual Assistance. However, VNTITs handles the Soviet distribution of East European abstracts and the acquisition of East European reports for Soviet users.⁶

¹See, for example, Dubinskaya, pp. 3-6; Belaya, pp. 2-3.

²A. I. Mikhaylov et al., *Nauchnye kommunikatsii i informatika* (Scientific Communications and Informatics), Nauka Publishing House, Moscow, 1976, p. 231.

³A study of the electrical engineering, machine-tool, and precision instrument industries found that the average size of the *otchet* for one completed project (*tema*) was 135 typewritten pages. G. I. Gol'dgamer, "The Creation of Documents and the Management of their Flows," *NTI*, Series 1, No. 8, 1974, p. 14. VNTITs is also a collection point for the algorithms and programs generated by the main computing centers of the branches and republics. V. S. Malov, "Information on Scientific Research and Experimental Design Projects," in *Nauka, informatsiya, proizvodstvo* (Science, Information, Production), VINITI, Moscow, 1977, p. 73.

⁴Mikhaylov et al., *Nauchnye kommunikatsii* (Scientific Communications), p. 231; V. A. Kopylov, "The Automated System of Information for Science and Technology in the Realm of Unpublished Documents (ASINIT)," *NTI*, Series 2, No. 1, 1976, p. 12.

⁵Mikhaylov et al., *Nauchnye kommunikatsii* (Scientific Communications), p. 231; and calculations from V. V. Sychev and E. N. Kazakov, "The System of Information on Scientific Research and Experimental Design Projects," *NTI*, Series 1, No. 11-12, 1977, p. 36. The VNTITs abstracts are written by the performers of the R&D work, not by members of the VNTITs staff.

⁶Novikov and Yegorov, p. 164. It is not clear from the sources I have consulted whether MTsNTI receives copies of the reports themselves. Note that Novikov and Yegorov do not list East Germany among the participants in MTsNTI activities.

This system of distribution has undoubtedly brought a substantial improvement in the availability of unpublished Soviet (and probably East European) documents. The sheer volume of material that VNTITs has accumulated and distributed is very impressive. There may be a problem, however, with the quality and accessibility of some of VNTITs's secondary guides to that material. The *Registration Bulletin of Research and Design Projects* has been faulted for describing projects only by vague titles. Furthermore, to consult the bulletin, researchers reportedly must go to the secret police office at R&D institutions.⁷ Users' access to the primary documents is probably even more affected by VNTITs's own difficulty in acquiring the reports. Despite the legal requirement to register R&D projects and file completed reports, apparently only a small fraction of the projects are actually registered with VNTITs, and VNTITs does not receive "a significant amount" of the finished reports.⁸ One information specialist with a close knowledge of VNTITs's operations stated that the number of organizations using its services exceeds by several times the number supplying information about their own R&D work. The absence of detailed Soviet studies prevents us from knowing the exact dimensions of this problem; but judging by the testimony of these Soviet observers, together with what we know about the obstructions that hamper the upward movement of other forms of information in the system, the difficulty appears to be substantial. The crux of the problem seems to be that researchers and designers derive no particular benefit from forwarding a copy of their final reports to VNTITs, and that the organization has no operational ability to identify and punish those who fail to do so. Although failure to register an R&D project carries some financial risk in that a project without a registration number is not supposed to be financed, no such risk exists to compel researchers to file a copy of their results once those R&D funds are spent. The responsibility for seeing that they file is formally vested in the ministry or department overseeing their work. But Soviet ministries and departments have often been censured for paying too little attention to the work of their subordinate R&D agencies, and it would not be surprising to learn that they make no effort to enforce this obligation.

VIMI (the All-Union Scientific Research Institute of Interbranch Information) shares with VNTITs the task of cataloging and disseminating unpublished reports. As noted in Section III, a knowledgeable emigre specialist indicated that VIMI's central responsibility is the handling of classified R&D reports. The rare descriptions of VIMI published inside the USSR, on the other hand, describe the organization elliptically, without referring to classified materials. This makes it impossible for us to obtain a full picture of the organization's activities. However, the limited data available suggest that in addition to managing the flow of classified reports, VIMI may be responsible for promoting the transfer of information from classified to nonclassified applications. The organization was founded in the late 1960s or early 1970s, about the time the Soviet regime was promoting civilian spin-offs from military R&D programs.⁹ The VIMI director's description of the organization's activities obliquely hints at

⁷V. N. Arkhangel'skiy, "The Use of Scientific-Technical Information in Planning and Managing Research and Development Projects," *NTI*, Series 1, No. 10, 1977, p. 5; telephone interview with Dr. Vladutz, August 1, 1980. Presumably the reason for this precaution is that the various series of the *Bulletin* give an unusually clear picture of the aggregate trends in unclassified Soviet R&D.

⁸Gol'dgamer, "The Creation," p. 16; Malov, p. 74. See also "Recommendations," in *Nauka, informatsiya, proizvodstvo* (Science, Information, Production), VINITI, Moscow, 1977, p. 426. One source states in passing that only 3 percent of the R&D projects undertaken each year are actually registered with VNTITs. (Yu. S. Nekhoroshev, "Scientific-Production Experience and the Mechanism of Its Dissemination," *Ekonomika i organizatsiya promyshlennogo proizvodstva*, No. 7, 1979, p. 7.)

⁹Dr. Vladutz recollects that he first heard of VIMI in 1967 or 1968 (telephone interview on July 29, 1980). A book published in 1974 states that VIMI was created "a few years ago." Novikov and Yegorov, p. 164. Creation of the organization may have been connected with two decrees on the improved interbranch circulation of information adopted in 1970 and 1971; see *Resheniya*, Vol. 8, 1972, pp. 228-230, 556-560. Brezhnev expressed the desire for more civilian spin-offs from military R&D in his speech to the 24th CPSU Congress in the spring of 1971. An account of the political fencing over military versus nonmilitary R&D during this period can be found in my *Politics and Technology in the Soviet Union*, MIT Press, Cambridge, Mass. (forthcoming).

the promotion of spin-offs as one of its jobs.¹⁰ VIMI receives reports on potentially useful R&D projects from "services" that evaluate the information at the level of the institute or enterprise, as well as at the level of the branch information agency. Usually, but not always, these services are part of the information department of the organization in question.¹¹ VIMI screens the recommended materials, having set up four interbranch councils of experts in 1975 for this purpose.¹² The most promising projects are included in the information sheets compiled and distributed by VIMI. From 1971 through 1975, 13,000 sets of material were submitted to the organization, two-thirds of which were accepted and publicized through the VIMI alerting services. It is worth noting that several examples of the materials publicized concern lasers.¹³ In contrast to VNTITs, VIMI reportedly does not maintain a collection of primary documents, perhaps for security reasons. If a recipient of a VIMI information sheet decides to order a primary document, he must send a prepaid indent to the address of the performer listed on the sheet; the latter is obligated to furnish a copy of the document within two months.¹⁴ In 1975 about 31,000 sets of documents were distributed in response to orders based on listings in VIMI information sheets.¹⁵ Although this volume of work seems quite small in comparison with the volume of distribution at VNTITs, VIMI probably disseminates a much larger quantity of classified documents through separate channels.

Several difficulties hamper VIMI's handling of unpublished reports. VIMI is unable to elicit information on all the relevant R&D work being done in the various R&D sectors. According to one observer, many documents never reach even the central branch organs that might pass them on to VIMI and other ministries.¹⁶ This happens largely because enterprises, institutes, and ministries show little concern for the effective transfer of information, particularly to other branches.¹⁷ The problem may reflect special difficulties in declassifying documents for general use, but it probably also reflects the same reluctance to pass information upward that is evident in other parts of the information system. Another difficulty is that customers using VIMI information sheets reportedly must wait long periods to receive copies of the documents they order from institutes and enterprises.¹⁸ Apart from the delays caused by security considerations, the shortage of copying equipment in most institutes and enterprises must contribute to such slow responses, besides making many organizations more reluctant to respond at all. According to one study of the flow of unpublished documents, many enterprises report only some of their technological achievements to the higher information organs because the enterprises fear being inundated with requests for copies which they cannot meet.¹⁹

Some unpublished documents are also handled by VINITI (the All-Union Institute of Scientific and Technical Information) and its affiliates. This system began to take shape in the early 1960s, when VINITI set up a repository for the unpublished manuscripts of researchers

¹⁰Thus, for example, he describes VIMI's work as involving the transmission of information "to the national economy." He uses the phrase twice, in a way which suggests that the information to be transferred has been generated in a noneconomic sphere of activity. See G. T. Artamonov, "The Organization of Work on the Mutual Use of Scientific-Technical Achievements by Branches of the Country's National Economy," in *Nauka, informatsiya, proizvodstvo* (Science, Information, Production), VINITI, Moscow, 1977, pp. 30-37.

¹¹*Ibid.*, p. 31.

¹²The four councils covered (1) machine-building, (2) precision instruments, (3) radio technology and electronics, and (4) chemistry and chemical manufacturing (*ibid.*, p. 33).

¹³*Ibid.*, pp. 33-35.

¹⁴*Ibid.*, p. 36.

¹⁵Calculated from *ibid.*, pp. 34-36. Another 54,000 were distributed on the basis of descriptions furnished by the central branch information organs.

¹⁶Gol'dgamer, "Status," pp. 9-10.

¹⁷Artamonov, p. 37.

¹⁸*Ibid.*

¹⁹Yu. M. Ivanov, "Several Questions on Improving Information Work," in *Nauka, informatsiya, proizvodstvo* (Science, Information, Production), VINITI, Moscow, 1977, p. 96.

working in the USSR Academy of Sciences. Subsequently, the system was expanded to include manuscripts forwarded by Academy journals, regardless of the researcher's affiliation. In 1971 it was further enlarged to include manuscripts on all research in the exact natural sciences.²⁰ VINITI is the principal, but not the sole, repository in the system. According to one calculation, VINITI handled 70 percent of the 40,000 manuscripts deposited from 1961 through 1977. The other 30 percent were processed by a network of supplementary depositories that now comprises 94 members.²¹ Like VINITI, many of these repositories issue secondary publications listing the manuscripts received so that readers may order copies. By one count, in 1977 VINITI furnished about 640,000 microfilm, xerox, and photographic copies of deposited manuscripts.²²

The VINITI system for handling unpublished scientific and technical material differs from those of VNTITs and VIMI in several respects. First, it is aimed at manuscripts originally intended for publication, rather than dissertations and reports produced without publication in mind. Second, it encompasses only the natural sciences, rather than the natural sciences and engineering. Third, it has in effect become centered on writings that usually do not exceed the length of a scientific article. One motive for establishing the system was to reduce the backlog of manuscripts in the offices of scientific journals by encouraging some authors not to publish their writings but instead to deposit them in a repository, where they could be obtained by other interested researchers.²³ In 1978 the average length of manuscripts accepted by VINITI for deposit was 14 to 15 pages, with 60 percent of the items submitted coming from the editorial boards of scientific journals.²⁴

Soviet commentators have mentioned several problems with this system for depositing manuscript. High publishing officials, who place considerable faith in repositories as a means of easing the pressures on the journal network, believe that too few manuscripts have been deposited. Many Soviet researchers are reluctant to forgo the personal and professional rewards connected with the formal publication of their work, and this reluctance has been strengthened by the unwillingness of some central agencies to treat a deposited manuscript as the equivalent of a published one.²⁵ For their part, journal editorial boards have reportedly sought to avoid depositing manuscripts, and have tried to shift the responsibility to individual scholars, higher educational institutions, and ministries.²⁶ The reason for this attitude is that manuscripts submitted for deposit are not automatically accepted. Like published articles, they require considerable editorial work by the submitting organization, and a journal board gets no special allowance for such work. It must still produce the same journal with the same staff, no matter how many manuscripts it sends for deposit.²⁷ Finally, there are problems with the production and distribution of copies of the deposited documents. While calling for an enlargement of repository activity, representatives of the USSR Academy have pointed out that limited access to copies of the manuscripts is a major impediment to their use, and they have urged VINITI to speed up the production of copies.²⁸

²⁰Mikhaylov et al., *Nauchnye kommunikatsii* (Scientific Communications), pp. 227-228.

²¹I. M. Basova and I. F. Kuznetsova, "The System for Depositing Scientific Works," *NTI*, Series 1, No. 12, 1978, pp. 2-4. A substantially lower figure for total manuscripts deposited (27,598) is given in "On Depositing Scientific Works," *Vestnik Akademii nauk SSSR*, No. 8, 1978, p. 4.

²²Basova and Kuznetsova, "The System," p. 2.

²³*Ibid.*, pp. 4-5.

²⁴*Ibid.*, pp. 2-4.

²⁵Stukalin. As one such agency, Stukalin cites the Higher Attestation Commission, which supervises the awarding of higher degrees and whose opinions are of major import for the careers of scholars. For a different opinion, see I. M. Basova and I. F. Kuznetsova, "On Depositing Scientific Works (from the Experience of VINITI)," *NTI*, Series 1, No. 8, 1975, p. 8.

²⁶Basova and Kuznetsova, "On Depositing."

²⁷*Ibid.*, p. 11. In 1973 VINITI returned 40 percent of the manuscripts submitted; in 1974 the figure was 23 percent.

²⁸"On Depositing," pp. 3-7.

VI. PATENTS, EQUIPMENT CATALOGS, AND OTHER ENGINEERING DOCUMENTS

Books, serials, and unpublished reports are not the only documentary channels of information transfer. Patent specifications, which contain much technical information not included in other sources, help R&D specialists to build on the accomplishments of other scientists and engineers. Equipment catalogs enable design engineers to incorporate the latest component machines into new products and new manufacturing layouts. Other engineering documents, such as reusable standardized designs for industrial plants, also facilitate the incorporation of advanced technology into large capital projects.

Since the early 1960s the Soviet government has steadily built up the system of bibliographic control over patent documents, both domestic and foreign. TsNIPI (the Central Scientific Research Institute of Patent Information and Technical-economic Studies) was established in 1962-1963. Under its auspices, secondary publications covering Soviet patent specifications have been expanded. After 1965, TsNIPI started to compile more comprehensive guides to the patent literature of selected Western countries. It abstracted Western patents and published the abstracts in Russian translation. By the early 1970s the guides included all the information contained in the official patent publications of the U.S., U.K., FRG, France, and Japan. In 1978 the guides were merged with the secondary sources covering Soviet inventions under the title *Inventions in the USSR and Abroad*. This title appears in 116 specialized series.¹

The Soviet authorities also expanded the supply of primary patent documents available to Soviet scientists and engineers. There are now 30 territorial patent centers, each containing an average of seven to nine million documents, and about 1100 branch patent repositories at various levels of the ministerial hierarchies.² In the past, the Soviet holdings of patent documents were concentrated primarily in Moscow. The major expansion of the network of patent libraries since the 1960s shows some effort to disperse the documents to sites more accessible to working scientists and engineers.

The emphasis on making patent information available has produced a substantial improvement. In 1965 Soviet citizens received only about 13,000 patents (i.e., patents proper plus authors' certificates) in the USSR. In the United States, Americans received about four times as many. By 1975 this gap had narrowed, with Soviets receiving about 42,000 patents in the USSR, as compared with 47,000 for Americans in the U.S.³ This increase suggests that the Soviet patent system is now carrying much more technical information than in the mid-1960s. Moreover, Soviet R&D personnel have better access to this information and are paying closer attention to it than in the past. In 1966, only 23 percent of the applications from Soviet organizations and institutes for Soviet patents were accepted. The rejections occurred primarily because specialists were poorly informed about patents that had already been granted. However, by 1973 through 1975 the average overall rate of acceptance for applications had risen to about 37 percent, indicating an advance in the circulation of patent documents.⁴ This rise made the Soviet acceptance rate comparable to that in some Western

¹A. N. Morozov, "Regarding the History of the Development of Patent Information in the Soviet Union," *Voprosy izobretatel'stva*, No. 5, 1979, pp. 36-40.

²L. K. Gorelov, "Patent Information in the USSR," *Voprosy izobretatel'stva*, No. 5, 1979, pp. 51-54.

³*Industrial Property*, Annex, December 1966; *Industrial Property: Statistics for 1975*, World Intellectual Property Organization, Geneva, 1976.

⁴Parrott, "The Organizational Environment," pp. 87, 99. The 1970s figure covers applications from both individuals and organizations. For the methodology used in computing it, see *ibid*.

industrial countries, although the Soviet rate remained significantly below that in the U.S. and France.⁵

While its salience has improved, Soviet patent information remains a relatively minor source of information for most Soviet R&D specialists. In 1972 VINITI surveyed the information practices of Soviet R&D personnel; about 2800 specialists completed the questionnaire. The survey revealed that specialists working in research institutes acquired only 2.5 percent of their scientific information from patent specifications, and specialists working in design bureaus and factories, only 4.5 percent. When tabulated according to the respondents' profession rather than workplace, the data revealed that engineers obtained only 3.5 percent of their information from patent specifications.⁶ Considering that the patents in question cover not only Soviet but most foreign inventions, this figure seems low at first glance. But in the absence of comparable studies of the utilization of patent data by Western scientists and engineers, we have no empirical reason to suggest that patent information is underutilized relative to other primary documents in the USSR.

If the management of patent literature constitutes a recent Soviet success, other varieties of technical documentation present a far less favorable picture. A number of Soviet designers have complained vociferously about the lack of reliable information on industrial equipment. Specialists designing new technology need information on the components available as inputs into that technology. Designers of new industrial plants, in particular, need to know what manufacturing equipment is available or will be available by the time plant construction begins. The necessary information should be contained in foreign and domestic industrial catalogs and other technical sources, but several designers indicate that it is not.

Catalogs on domestic output in particular industrial sectors are generally prepared by the branch information agency of the ministry that produces these goods. The branch agencies are apparently responsible for providing domestic catalogs both to design organizations and to the Department of Industrial Catalogs of the State Public Scientific and Technical Library in Moscow. In addition, foreign catalogs are channeled from the Ministry of Foreign Trade to this department, where they are copied. The copies are sent to branch and regional information organs for distribution to designers.⁷ At the end of 1977 the Catalog Department had 2.8 million foreign and domestic catalogs. Of these, one million per year were loaned to other organizations.⁸

Several Soviet designers have complained that they obtain too little information about foreign equipment under these arrangements. One outspoken official termed the provision of such information "totally disorganized," asserting that the Catalog Department follows an erratic acquisitions policy, preserves the materials poorly, and supplies too few of them to users because it regards itself as a passive library.⁹ Other Soviet critics have agreed that information on foreign equipment is insufficient. Some have suggested that many proposals from foreign firms to provide equipment or whole plants never reach Soviet design organizations because the proposals are held up by the Ministry of Foreign Trade.¹⁰ The centralized structure of the Soviet economic system, reflected in the Ministry's tight control over the flow of physical goods, apparently also leads to restrictions on the flow of technical

⁵Ibid.

⁶A. I. Cherniy, V. A. Markusovsa, and A. V. Engel'gardt, "The Use of Various Sources of Scientific Information by Industrial Specialists (Several Results from a Questionnaire)," *NTI*, Series 1, No. 11, 1974, pp. 5, 7. The questionnaire took account of information received through published sources and informal sources such as personal contacts, but not through unpublished written reports.

⁷A. I. Litsman and T. V. Pogorelova, "The Use of Foreign Materials for Informing Specialists from Scientific Research Institutes," *NTI*, Series 1, No. 10, 1977, p. 12; "Recommendations," p. 344.

⁸Knyazeva, p. 66.

⁹G. S. Rudakov, "The Role of Catalog-Reference Information on Equipment in Increasing the Quality and Effectiveness of Design Work," in *Nauka, informatsiya, proizvodstvo*, p. 298.

¹⁰M. A. Shlosberg and G. B. Sycheva, "Complex Design Organizations' Demands for Scientific-Technical Information," in *Nauka, informatsiya, proizvodstvo*, p. 275.

information. (Some designers also complain that they cannot obtain information on the technical parameters of foreign industrial plants to use as baselines for their own work, although it is an open question whether Western corporate designers have any greater access to such data on the operations of rival Western companies.)¹¹ As a remedy, Soviet commentators have urged that the intermediate information organs receive fewer copies of foreign catalogs, and the design organizations more; but this plea has produced little change.¹² The barriers between Soviet designers and foreign sources of information about physical technology remain high.

Similar obstacles impede the dissemination of information about industrial equipment produced domestically. In 1968 the government decreed that each industrial ministry should ensure that every new product be recorded in published catalogs no later than three months after the first production run, and that termination of the manufacture of any product should be announced one to two years in advance.¹³ In 1977, however, published catalogs still covered only 80 percent of the series output in the machine-building industries, and the catalogs reportedly still appeared 8 to 11 months late.¹⁴ For example, the representative of an organization that designs engineering plants reported that of 11 types of equipment manufactured in 1976, catalog information on two types reached his institute in July of that year. Information on three other types came in September and October, and as of the end of October, information on five other types had not yet arrived. Moreover, the catalogs for some of these categories of equipment covered only 20 to 72 percent of the total series output of that type of machinery.¹⁵

Designers agree that even when domestic catalogs are available, the information that they contain is incomplete and unreliable. Most published catalogs do not contain such essential technical details as full drawings of the foundations of heavy machines, the points of energy and water input, the dimensions of ancillary equipment, and price.¹⁶ Perhaps most seriously, the catalogs sometimes misleadingly describe machines that have been withdrawn from production as still being produced, and the bulletins that are supposed to announce such withdrawals in advance actually arrive well after the withdrawals have occurred.¹⁷

This situation has serious negative consequences. Lacking reliable published catalogs, the project-design organizations are compelled to create their own, which are printed in editions of only 20 or 30 each.¹⁸ This involves a very large duplication of effort. Every year, each design organization must send factories "several thousand" letters and telegrams, as well as special couriers, to inquire about the specifications of available equipment. One spokesman said this situation forces his institute to maintain regular correspondence with about 1200 factories.¹⁹ Moreover, only 50 to 70 percent of a designer's postal inquiries receive replies, according to one source.²⁰ Consequently, designers must expend a great deal of energy on nondesign work, only to remain poorly informed. The shortage of accurate information forces designers to rework many completed designs, thereby delaying the process of innovation via capital construction. The consequences are worse when designers face tight deadlines for completing their organization's planned volume of work. In these circumstances designers

¹¹Ibid.

¹²Litsman and Pogoredlova, p. 12; "Recommendations," p. 344.

¹³*Resheniya*, Vol. 7, 1970, p. 114.

¹⁴A. Ye. Murygin, "The Role of Scientific-Technical Information in Increasing the Effectiveness and Quality of Design Work," in *Nauka, informatsiya, proizvodstvo*, p. 232.

¹⁵I. F. Sukhov, "Types and Procurement Sources of Information Materials for Design Work," in *Nauka, informatsiya, proizvodstvo*, p. 268.

¹⁶Rudakov, p. 295; "On the Work of the September-December 1978 Seminar 'The Theory and Practice of Scientific-Technical Information,'" *NTI*, Series 1, No. 4, 1979, p. 26.

¹⁷Shlosberg and Sycheva, p. 272; "On the Work," p. 26; Murygin, p. 232.

¹⁸Rudakov, p. 295.

¹⁹Ibid.; Shlosberg and Sycheva, p. 276.

²⁰Shlosberg and Sycheva, p. 276.

often simply forgo the verification of catalog specifications and give the construction agencies plans calling for nonexistent pieces of equipment. The builders must then try to remedy the mistakes during actual construction—an extremely expensive way to correct erroneous information.²¹

The circulation of other kinds of engineering documents appears to be little better. Governmental directives on design procedures are reportedly printed in inadequate amounts. Project organizations occasionally seek to remedy this problem by printing their own copies, but the shortage of copies sometimes necessitates the reworking of plans that have been inadvertently designed in violation of the current guidelines.²² It is equally difficult to obtain copies of standard construction designs, and the ministries reportedly distribute the limited editions of equipment price lists to purchasing enterprises rather than to the organizations designing new plants.²³ Designers emphasize strongly that obtaining technical documents from other design organizations is very difficult because most organizations lack the copying equipment to provide the documents and because any proceeds garnered from such transactions must be paid into the state budget.²⁴

These costly bottlenecks in the dissemination of engineering information—especially true of the lack of timely and accurate equipment catalogs—will not be easy to remove. Most Soviet ministries occupy a monopolistic position, and the seller's market gives them little incentive to provide better information on their output. The government has repeatedly enjoined them to do so, but with no apparent effect. The centralized nature of the Soviet economy also contributes to this situation. Because the economy is vulnerable to chain reactions in which an unexpected change in the manufacture of one product forces changes in the manufacture of others, the ministries sometimes cannot accurately predict which machines will be produced, or when. Without this information, they cannot create reliable catalogs for industrial designers to use.

²¹Rudakov, p. 297; "On the Work," p. 28.

²²Shlosberg and Sycheva, p. 272; "The Books We Are Waiting For," *Stroitel'naya gazeta*, March 18, 1979, p. 4.

²³Shlosberg and Sycheva, p. 273; Murygin, p. 233.

²⁴Murygin, pp. 234-235; P. P. Borozdin, "The Organization of Information Supply in Design Institutes," in *Nauka, informatsiya, proizvodstvo*, p. 262.

VII. CONCLUSIONS

Since the death of Stalin, the Soviet regime has paid increasing attention to the management of scientific and technical information. No longer believing that information policy can be treated simply as a derivative of policies in other fields, it has supported a large amount of scholarly research on information systems, built up an extensive network of information agencies, and striven to adopt concerted measures in this realm.

As a result, the regime has made major strides in managing documentary information flows. It has created a massive and effective system for indexing and abstracting both foreign and domestic published information. It has inaugurated a very-large-scale effort to collect, index, and distribute unpublished scientific and technical reports. And it has substantially improved the secondary coverage and accessibility of domestic and foreign patent literature. These are worthy attainments, and they should not be neglected in any account of the Soviet information system.

At the same time, the regime has encountered serious difficulties in upgrading the documentary transfer of scientific and technical information. Progress toward computerized SDI services has been extremely slow and will probably remain modest in the foreseeable future. The network of information departments at the lower levels of the system is poorly staffed and underequipped, offering little assistance to specialists trying to obtain primary documents. The publishing system does not process and disseminate domestically generated information as rapidly as some Western countries do. The publishing delays and the relatively small number of technical journals indicate a serious deficiency in the transmission of information between the applied research and production phases of the R&D cycle. Moreover, the international exchange of information represents another bottleneck. Foreign documents reach Soviet specialists with very costly delays. Access to such sources is particularly difficult for researchers outside the major metropolitan centers, who also seem to experience difficulty obtaining domestic documents. Finally, the disorganized handling of some engineering documents obstructs technological innovation in capital construction. The transfer of information within this phase of the R&D cycle seems to be especially weak.

This formidable array of problems helps explain why the Soviet system, despite a vast supply of specialized manpower and heavy R&D expenditures, still lags behind the West in a number of scientific and technical fields. The barriers to the exchange of information in the USSR mean that a large amount of useful domestic and foreign information is either lost or underutilized. To some extent, of course, the R&D network of every developed country wastes information. But the inefficiency of Soviet information exchange seems to be exceptionally great. The extent of this inefficiency supports the view that the USSR obtains a significantly smaller rate of return on its R&D expenditures than do many Western countries. The evidence also suggests that the USSR, while it may conceivably absorb foreign scientific and technical ideas efficiently in a few individual sectors, generally makes poor use of the foreign information available through formal channels. The process of informal communication has not been considered here; it will be examined in a companion report. But it is worth noting that Soviet restrictions on informal communication, which is an essential precondition for effective formal communication, probably compound these difficulties.

Although the Soviet government will continue working to reduce the inefficiency of information transfer, the number of problems and their scope suggest that the regime has little hope of achieving a sudden jump in the effectiveness of the transfer process as a whole. The Soviet information system reflects, in large measure, the characteristics of the general political and social system. Soviet accomplishments in information management, such as the ex-

tensive indexing and abstracting of documents, are based primarily on the regime's capacity to concentrate resources and achieve economies of scale. Scholars frequently note this ability as a source of Soviet advances in other realms, be they military, industrial, or scientific. The weaknesses of the information system likewise mirror the defects of the society as a whole. The problems of computerizing secondary information exemplify the bureaucratic autarky and neglect of technological quality that occur at other points in the economy. Bearing a noteworthy resemblance to the chronic bottlenecks among various economic sectors, the imbalance between massive R&D expenditures and the limited scale of scientific publishing reflects the regime's tendency toward disproportional development of activities that should be balanced for maximum efficiency.

In addition to reflecting the dominant features of the Soviet economic system, the limits on publishing and the shortage of copying equipment mirror political realities. Officials assign low value to unrestricted public communication, particularly when such interchange competes with other forms of communication (such as political indoctrination) that the government values more. Further, the regime's persisting isolation from the outside world, and its deep-seated fear of foreign contacts, hinder adequate access to foreign scientific and technical documents. Although these aspects of Soviet society may change, leading to some improvement in the handling of scientific and technical information, a substantial improvement is likely to occur only over the long term.

Appendix

CIRCULATION OF SELECTED SOVIET SCIENTIFIC JOURNALS IN THE PHYSICAL SCIENCES, DECEMBER 1976

Section IV notes that Soviet scientific journals are published in smaller numbers than are similar American journals. The author reached this conclusion by comparing the printing runs of a sample of top-flight Soviet journals with the figures for American journals given in Section IV. The Soviet data were compiled from the standard publication information presented in the last number of each journal for 1976.

<i>Journal Name</i>	<i>Circulation</i>
Akademiya nauk Estonskoy SSR. Izvestiya. Fizika, matematika	890
Akademiya nauk Latviyskoy SSR. Izvestiya	850
Akademiya nauk SSSR. Doklady	3355
Akademiya nauk SSSR. Izvestiya. Energetika i transport	1600
Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya	1925
Akademiya nauk SSSR. Izvestiya. Seriya Khimicheskaya	2130
Akademiya nauk SSSR. Izvestiya. Mekhanika tverdogo tela	1705
Akademiya nauk SSSR. Izvestiya. Metally	1660
Akademiya nauk SSSR. Izvestiya. Neorganicheskiye materialy	1260
Akademiya nauk Ukrainskoy SSR. Dopovidi. Seriya A: Fiziko-matematichni ta tekhnichni nauki	920
Akademiya nauk Ukrainskoy SSR. Dopovidi. Seriya B: Geologichni, khimichni ta biologichni nauki	975
Akademiya nauk Uzbekskoy SSR. Doklady	849
Atomnaya energiya	2510
Fizika atmosfery i okeana	1120
Fizika goreniya i vzryva	1592
Fizika i tekhnika poluprovodnikov	1755
Fizika metallov i metallovedeniye	2170
Fizika tverdogo tela	2145
Geomagnetizm i aeronomiya	800
Geodeziya i kartografiya	9080
Izvestiya vysshikh uchebnykh zavedeniy. Fizika	1980
Izvestiya vysshikh uchebnykh zavedeniy. Geodeziya i aerofotos'yemka	2276
Izvestiya vysshikh uchebnykh zavedeniy. Geologiya i razvedka	2420
Khimiya vysokikh energiy	725
Kinetika i kataliz	1565
Kristallografiya	1610
Magnitnaya gidrodinamika	1040

Pis'ma v Zhurnal eksperimental'noy i teoreticheskoy fiziki	1250
Pribory i tekhnika eksperimenta	6385
Prikladnaya matematika i mekhanika	2835
Prikladnaya mekhanika	1960
Optika i spektroskopiya	2200
Teoreticheskaya i matematicheskaya fizika	1080
Ukrainskiy fizicheskoy zhurnal	915
Uspekhi fizicheskikh nauk	4510
Zhurnal eksperimental'noy i teoreticheskoy fiziki	2275
Zhurnal fizicheskoy khimii	2570
Zhurnal neorganicheskoy khimii	2065
Zhurnal prikladnoy khimii	2744
Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki	2084
Zhurnal tekhnicheskoy fiziki	2269
Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki	2745

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